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The American Midland Naturalist

Devoted to Natural History, Primarily that of the Prairie States

Founded by J. A. Nieuwland, C.S.C.

Edited by Theodor Just

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VOL. 32 NOVEMBER, 1944 NO. 3

A Contribution to Our Knowledge of the Wild and Cultivated Flora of Florida—I

Harold N. Moldenke

The present contribution lists 2371 collections made in the state of Florida, mostly during the years 1927, 1929, and 1930. These collections represent 182 botanical families, 737 genera, and 1349 species and varieties. Most of the specimens herein cited were submitted to and identified by the late Dr. John K. Small and a good many are the basis for statements or inclusions in his "Manual of the Southeastern Flora" (1933), where, however, no individual specimens are cited in substantiation of records. Several represent species not recorded in the "Manual." A great many of the specimens have also been submitted to specialists in various groups and their determinations, especially when these differ from those of Dr. Small, are given herewith. Among the specialists who have thus identified material and to whom I wish to extend formal thanks for this valuable service are Dr. Oakes Ames (*Orchidaceae*), Dr. E. A. Anderson (*Tradescantia*), Dr. L. H. Bailey (*Arecaceae, Eranthemum, Ficus, Operculina, Passiflora, Psilorhegma, Thunbergia*), Dr. J. H. Barnhart (*Lentibulariaceae*), Dr. C. H. K. Blom (*Solanum*), the late Dr. N. L. Britton (*Caesalpiniaceae, Cyperaceae*), Dr. Leon Croizat (*Phyllanthus*), Mr. Arthur Cronquist (*Simarouba*), Dr. Carl Epling (*Salvia, Scutellaria*), Dr. H. A. Gleason (*Echinochloa*), Dr. H. T. Goodspeed (*Nicotiana*), the late Dr. A. S. Hitchcock (*Poaceae*), the late Dr. M. A. Howe (algae), Mr. E. P. Killip (*Anisostichus, Passiflora*), Dr. Maxine Larisey (*Baptisia*), the late Mr. K. K. Mackenzie (*Carex*), Dr. W. A. Maxon (ferns), Mr. Joseph Monachino (miscellaneous redeterminations) Dr. P. A. Munz (*Gaura*), Dr. F. W. Pennell (*Scrophulariaceae*), Dr. Alfred Rehder (*Crataegus, Prunus*), the late Dr. P. A. Rydberg (*Amorpha, Cracca, Helenium, Physalis, Rosa, Rubus*), Dr. W. C. Steere (mosses), Dr. E. T. Wherry (*Phlox*), Mr. Percy Wilson (*Borreria, Eugenia, Portulaca*), Dr. R. E. Woodson, Jr. (*Tradescantia*), and Dr. T. G. Yuncker (*Cuscutaceae*). My most sincere thanks are also due to Mr. Walter M. Buswell, Mr. Richard F. Deckert, and the late Mr. Charles A. Mosier, who so generously gave of their time and energy in acting as my companions and guides in various portions of the state.

A few of the specimens herein reported were not collected by myself, but, having been presented to me for my herbarium, have been assigned serial collection numbers in the same sequence with my own collctions to simplify citation. Among these other collectors whose material is here cited are Mr. W.

M. Buswell (1914, 1930), Mrs. E. O. Groves (1929), Dr. M. A. Howe (1902, 1904), Mr. C. A. Mosier (1929, 1930), Dr. J. K. Small (1927), Mrs. J. R. Swanson (1938), and Dr. E. T. Wherry (1930). The vast majority of the material, however, was collected by my father, the late Dr. Charles Edward Moldenke[1], and myself. Although the labels give only my name as collector, it should be recorded that about half of the 23,000 specimens collected were gathered by my father and that he did practically all of the tedious and most uncomfortably hot work of numbering, pressing, and drying, thus liberating more of my time for exploration and further collecting. In fact, it was his inexhaustible fund of energy and enthusiasm and his mature advice and guidance which made possible the successful fruition of our three botanizing trips into the state. Whatever I may now know of the flora of this fascinating state, and, in fact, whatever I may have achieved in the field of botany, I owe to his patient and self-sacrificing interest, guidance, and inspiration.

The sequence of families followed in this paper is that of my "A Preliminary Classification of the Plant Kingdom to Families" (37 pp., 1944), which, in turn, is based, with many modifications, on the system of Engler & Gilg, Engler & Diels, and J. Hutchinson. The first set of the specimens herein cited has been deposited in the herbarium of the New York Botanical Garden. Duplicate sets are in the herbaria of the Royal Botanic Gardens at Kew, the Botaniska Trädgard at Göteborg, the Missouri Botanical Garden, the University of Pennsylvania, Duke University, Carthage College, the University of Illinois, Bailey Hortorium, the British Museum, the Naturhistoriska Riksmuseet at Stockholm, the Jardin Botanique de l'Etat at Brussels, the Botanisches Museum at Berlin, the Conservatoire Botanique at Geneva, the herbaria at Krakow and Vyskov, and numerous other botanical institutions all over the world.

All the collection numbers herein cited are H. N. Moldenke collection-numbers and the vast majority are cited (without exact locality of collection or habitat notes) in my mimeographed "An annotated and classified list of H. N. Moldenke collection numbers from No. 1 to No. 11,277, inclusive" (135 pp., 1939). Several hundred of the collections have been re-identified since the original material (mostly in sets of 10) was distributed. In these cases the name under which the material was distributed by me is given as a note so that appropriate corrections may be made by herbarium curators. Counties are listed alphabetically where material from more than one county is cited for a given species or variety.

VALONIACEAE

Dictyosphaeria favulosa (Agardh) Decaisne—*Monroe Co.:* washed ashore, Key West, *1909*, collected and determined by M. A. Howe.

DASYCLADACEAE

Acetabularia farlowi Solms—*Dade Co:* on shore of Biscayne Bay, Miami, *1919*, collected and determined by M. A. Howe.

Cymopolia barbata (L.) Harvey—*Monroe Co.:* washed ashore, Key West, *1908*, collected and determined by M. A. Howe.

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1 Dictionary of American Biography **13**:79. 1931; Science, new ser., **81**:191. 1935; National Cyclopaedia of American Biography **24**:54 & 55. 1935; Encyclopedia of American Biography **4**:292-294. 1935; White's Conspectus Am. Biog., ed. 2, 307. 1937; Who Was Who in America **1**:853. 1942.

DICTYOTACEAE

Padina vickersiae Hoyt—*Dade Co.:* floating, Jupiter Inlet, *1907*, collected and determined by M. A. Howe.

USTILAGINACEAE

Mycosyrinx cissi (P. DC.) G. Beck—*Dade Co.:* parasitic on *Cissus sicyoides* in moist soil along Miami River, Miami, *3619*. *Martin Co.:* parasitic on *Cissus sicyoides*, about 1 mile north of Fort Mayaca, *247a*.

FUNARIACEAE

Funaria calvescens (Schwaegr.) B.S.G.—*Dade Co.:* in moist soil, Cox Hammock, west of Goulds, *642*, det. Steere, originally distributed as *F. hygrometrica* (L.) Sibth.

POLYPODIACEAE

Acrostichum aureum L.—*Collier Co.:* in sandy mangrove swamp near Caxambas, *1003*. *Dade Co.:* in swampy ground, Seminole Plains, Black Point, *5541*.

Acrostichum danaeaefolium Langsd. & Fisch.—*Dade Co.:* in swamp, Fulford, *393;* in everglades 25 miles west of Miami, *3760*, det. as *A. excelsum* Maxon by Maxon. *Orange Co.:* in wet swampy soil, Orlando, *5330*. These three collections were originally distributed as *A. excelsum*.

Adiantum tenerum Sw.—*Dade Co.:* in lime-sink, Hattie Bauer Hammock, Redlands district, *565*.

Anchistea virginica (L.) Presl—*Broward Co.:* in hammock, west of Pompano, *464*. *Glades Co.:* at edge of slough, near Citrus Center, *8391*. *Osceola Co.:* in bog, Deer Park, *8050*.

Asplenium verecundum Chapm.—*Dade Co.:* in well-like lime-sink, Cox Hammock, west of Goulds, *645a*.

Blechnum serrulatum L. C. Rich.—*Broward Co.:* in hammock, west of Pompano, *461*. *Dade Co.:* in hammock, Miami, *334;* in hammock along Tamiami Trail, 25 miles west of Miami, *3763*, det. Maxon. *Lee Co.:* along edge of wet hammock, Fort Myers, *5777*. *Osceola Co.:* in bog, Deer Park, *5407*.

Campyloneurum phyllitidis (L.) Presl—*Dade Co.:* on moss-covered fallen log, Hattie Bauer Hammock, Redlands district, *569;* in cultivation, Miami, *3617;* epiphytic on prostrate tree trunk, Hattie Bauer Hammock, Redlands district, *5647*.

Dryopteris ludoviciana (Kunze) Small—*Lake Co.:* in wet boggy woods, near Astatula, *5370*, originally distributed as *D. floridana* (Hook.) Kuntze.

Goniopteris reptans (J. F. Gmel.) Presl—*Dade Co.:* in well-like lime-sink, Cox Hammock, west of Goulds, *646a;* in lime-sink, Cox Hammock, west of Goulds, *5755*. Both these collections were originally distributed as *Dryopteris radicans* (L.) Maxon.

Litobrochia tripartita (Sw.) Presl—*Broward Co.:* in hammock, west of Pompano, *470*, *470a*. Both these collections were originally distributed as *Pteris tripartita* Sw.

Marginaria polypodioides (L.) Tidestr.—*Dade Co.:* epiphytic on *Quercus virginiana* in hammock, Little River, *443;* on coral bank, Miami, *3618*.

Nephrolepis biserrata (Sw.) Schott—*Broward Co.:* in hammock, west of Pompano, *483*.

Nephrolepis exaltata (L.) Schott—*Dade Co.:* in hammock, Little River, *436*, *437;* in hammock along Tamiami Trail, 25 miles west of Miami, *3761*, det. Maxon.

Phlebodium aureum (L.) J. E. Sm.—*Dade Co.:* epiphytic among "boots" of *Sabal palmetto*, Buena Vista, *445*. *Orange Co.:* epiphytic in "boots" of *Sabal palmetto*, about 2 miles east of Fort Christmas, *5382*.

Phymatodes heterophyllum (L.) Small—*Monroe Co.:* climbing up smooth-barked tree-trunk, Key Largo, *5539*.

Pteridium caudatum (L.) Maxon—*Broward Co.:* in hammock on Long Island, west of Davie, *504a*. *Dade Co.:* at edge of hammock along Tamiami Trail, 25 miles west of Miami, *3759*, det. as *Pteris caudata* L. by Maxon. *Monroe Co.:* in hammock, north end of Key Largo, *408*. These three collections were distributed as *Pteris caudata* L.

Pycnadoria bahamensis (Agardh) Small—*Dade Co.:* in Hattie Bauer Hammock, Redlands district, *547*, distributed as *P. pinetorum* Small; in everglades near hamrock along Tamiami Trail, 25 miles west of Miami, *3758*, distributed as *Pteris longifolia* var. *bahamensis* (Agardh) Hieron.; in dry sandy pineland, Buena Vista, Miami, *5563*, distributed as *P. pinetorum*.

Pycnadoria vittata (L.) Small—*Dade Co.:* in dry sandy soil along roadside near Royal Palm Park, Paradise Key, *829;* in moist soil on canal embankment, near Big Bend, on Tamiami Trail, *848*.

Tectaria heracleifolia (Willd.) Underw.—*Dade Co.:* in lime-sink, Hattie Bauer Hammock, Redlands district, *609a*.

Tectaria minima Underw.—*Dade Co.:* in well-like lime-sink, Hattie Bauer Hammock, Redlands district, *546*.

Thelypteris gongylodes (Schk.) Small—*Broward Co.:* in hammock west of Pompano, *471*, distributed as *Dryopteris gongyloides* (Schk.) Kuntze.

Thelypteris normalis (C. Chr.) Moxley—*Broward Co.:* in hammock west of Pompano, *481*, distributed as *Dryopteris thelypteris* (L.) A. Gray. *Dade Co.:* in Hattie Bauer Hammock, Redlands district, *547a*, distributed as *Dryopteris thelypteris;* in dry sandy soil at edge of hammock, Cutler district, *736*, distributed as *Dryopteris normalis* C. Chr.: in moist soil on canal embankment along Tamiami Trail, *846*, *847* [both collections det. as *Dryopteris normalis* by Maxon]; at edge of canal, Tamiami Trail, *5864*, distributed as *Dryopteris normalis*.

Thelypteris palustris var. *haleana* Fernald—*Dade Co.:* in hammock along Tamiami Trail, 25 miles west of Miami, *3762*, det. as *Dryopteris thelypteris* (L.) A. Gray by Maxon. *Lee Co.:* in moist hammock, Fort Myers, *950*. *Martin Co.:* in boggy soil about 1 mile north of Fort Mayaca, *5441*. These three collections were distributed as *Dryopteris thelypteris;* no. 5441 was recorded in my "Annotated List" as *D. thelypteris* var. *pubescens* (Lawson) A. Prince.

Thelypteris patens (Sw.) Small—*Dade Co.:* in hammock, Royal Palm Park, Paradise Key, *828*, distributed as *Dryopteris patens* (Sw.) Kuntze.

Vittaria lineata (L.) Sw.—*Dade Co.:* epiphytic in "boots" of *Sabal palmetto*, Hattie Bauer Hammock, Redlands district, *569a;* epiphytic on *Sabal palmetto*, Little River, *5560*.

SCHIZAEACEAE

Anemia adiantifolia (L.) Sw.—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *322;* on sandy coral embankment, Miami, *3616;* in lime-sink, Cox Hammock, west of Goulds, *5756*.

OSMUNDACEAE

Osmunda cinnamomea L.—*Osceola Co.:* in bog, Deer Park, *5408*, distributed as *Dryopteris thelypteris* (L.) A. Gray.

Osmunda spectabilis Willd.—*Broward Co.:* in wet sandy soil west of Pompano, *467*. *Lake Co.:* on wet fallen logs, near Astatula, *5365*, *5366*. These three collections were distributed as *O. regalis* L.

LYCOPODIACEAE

Lycopodium alopecuroides L.—*Orange Co.:* in wet sandy field about 3 miles west of Bithlo, *5377*.

Lycopodium cernuum L.—*Manatee Co.:* in wet ditch about 5 miles north of Parrish, *5923*. *Orange Co.:* in bog near Orlando, *5794*, collected by W. M. Buswell.

SELAGINELLACEAE

Selaginella funiformis Van Eseltine—*Dade Co.:* in dry sand in *Ceratiola* association, Miami, *882*.

Selaginella willdenowii Baker—*Dade Co.:* in cultivation, Buena Vista, Miami, *5567*.

PSILOTACEAE

Psilotum nudum (L.) Griseb.—*Broward Co.:* on bole of *Taxodium distichum*, west of Pompano, *477a*.

CYCADACEAE

Zamia integrifolia Ait.—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *320;* in sandy pineland, Little River, *440;* in waste ground, Miami, *3648. Glades Co.:* in sandy pineland near Citrus Center, *8393.*

Zamia silvicola Small—*Broward Co.:* in dense hammock, Long Island, west of Davie, *504. Dade Co.:* in Cox Hammock, west of Goulds, *5754.*

TAXACEAE

Tumnion taxifolium (Arn.) Greene—*Franklin Co.:* along the Apalachicola River, Apalachicola, *5588a,* collected by C. A. Mosier.

PINACEAE

Pinus australis Michx.—*Dade Co.:* in dry sandy pineland, Opa-Locka, *888, 889.*

Pinus caribaea Morelet—*Dade Co.:* in dry sandy pineland, Miami, *491.*

Pinus clausa (Engelm.) Vasey—*Collier Co.:* in dry sandy field in *Ceratiola* association, Naples, *996.*

Pinus glabra Walt.—*Seminole Co.:* in sandy woods about 1½ miles south of Sanford, *5350.*

Pinus serotina Michx.—*Clay Co.:* in sandy pineland about 2 miles north or Orange Park, *5236.*

TAXODIACEAE

Taxodium ascendens Brongn.—*Monroe Co.:* in everglades, Pine Crest, *859.*

CUPRESSACEAE

Sabina silicicola Small—*Duval Co.:* about 4 miles east of Eastport, *5286.*

MAGNOLIACEAE

Magnolia grandiflora L.—*Hernando Co.:* in cultivation, Brooksville, *5941.*

Magnolia virginiana L.—*Dade Co.:* at edge of canal along Tamiami Trail, *866;* at edge of canal, Buena Vista, Miami, *5513. Highlands Co.:* at edge of thicket, near Childs, *5419.*

ANNONACEAE

Annona glabra L.—*Collier Co.:* in wet hammock south of Tamiami Trail, *869a, 5867. Dade Co.:* in everglades at edge of hammock along Tamiami Trail, 25 miles west of Miami, *3765.*

Deeringothamnus pulchellus Small—*Lee Co.:* in sand along roadside, Big Pine Island, *930, 981.* This is a very rare species.

Deeringothamnus rugelii (B. L. Robinson) Small—*Volusia Co.:* in sandy soil west of New Smyrna, *481a,* a very rare species, collected by C. A. Mosier.

Pityothamnus angustifolius (A. Gray) Small— *Columbia Co.:* in dry sandy field, north of High Springs, *1097;* in dry sandy field, south of Ellisville, *1089.* Both collections were distributed as *Asimina angustifolia* A. Gray.

Pityothamnus incanus (Bartr.) Small—*Levy Co.:* in dry sandy oak woods, south of Morriston, *1082a,* distributed as *Asimina speciosa* Nash.

Pityothamnus obovatus (Willd.) Small—*Hernando Co.:* in dry sandy oak woods, north of Aripeka, *1067,* distributed as *Asimina obovata* (Willd.) Nash.

Pityothamnus pygmaeus (Bartr.) Small—*Hernando Co.:* in dry sandy oak woods, southwest of Brooksville, *1069a,* distributed as *Asimina pygmaea* (Bartr.) A. Gray.

Pityothamnus reticulatus (Chapm.) Small—*Dade Co.:* in dry sandy field, Opa-Locka, *450,* distributed as *Asimina reticulata* Shuttlw.

LAURACEAE

Cinnamomum camphora Nees & Eberm.—*Hernando Co.:* in cultivation, Brooksville, *5937.*

Ocotea catesbyana (Michx.) Sarg.—*Dade Co.:* in hammock, west of Fulford, *5571;* in hammock, Brickell Hammock, Miami, *5630.*

Persea americana Mill.—*Dade Co.:* in cultivation, Miami, *3611;* in cultivation, Coconut Grove, *5694. Monroe Co.:* in dry sandy waste ground, Key West, *842.*

Tamala borbonia (L.) Raf.—*Broward Co.:* in hammock on Long Island, west of Davis, *5603*. *Dade Co.:* in sandy waste ground near canal, Miami, *3675;* at edge of hammock, south of Florida City, *5818*. *Volusia Co.:* in dry sandy soil, Mosquito Inlet, *5311*.

Tamala littoralis Small—*Collier Co.:* in dry sandy soil, Caxambas, *1000*.

Tamala pubescens (Pursh) Small—Dade Co.: at edge of canal, Tamiami Trail east of Big Bend, *5514*. *Monroe Co.:* in wet hammock, Pine Crest, *854*.

CASSYTHACEAE

Cassytha filiformis L.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *372;* in waste patch, Miami, *3696*.

RANUNCULACEAE

Viorna baldwinii (T. & G.) Small—*Brevard Co.:* in dry sandy soil, Merritt's Island, *217;* in dry sandy soil along roadside, near Melbourne, *5396*. *Dade Co.:* in dry sandy pineland, Goulds, *640, 5643*.

NYMPHAEACEAE

Castalia lekophylla Small—*Leon Co.:* plants submerged in about 3 feet of water in pond, Tallahassee, *1174*.

ARISTOLOCHIACEAE

Aristolochia elegans Mast.—*Dade Co.:* in cultivation, Buena Vista, *5449;* in cultivation, Miami, *5596*, det. Bailey, distributed as *Solanum seaforthianum* Andr.

Aristolochia maxima Jacq.—*Dade Co.:* apparently escaped from cultivation in Deering estate, Buena Vista, Miami, *709, 5551*.

PIPERACEAE

Peperomia floridana Small—*Dade Co.:* on fallen moss-covered log, Sykes Hammock, Redlands district, *558*.

Peperomia obtusifolia (L.) A. Dietr.—*Monroe Co.:* on fallen moss-covered log, Cape Sable region, *833*.

Piper auritum H.B.K.—*Dade Co.:* in cultivation, Miami, *5874*, det. Bailey.

Piper betle L.—*Dade Co.:* in cultivation, near Miami, *10374*.

SAURURACEAE

Saururus cernuus L.—*Monroe Co.:* in everglades, Pine Crest, *360*.

PAPAVERACEAE

Argemone alba Lestib.—*Pinellas Co.:* in sandy soil along railroad embankment, Palm Harbor, *1059*.

Argemone leiocarpa Greene—*Monroe Co.:* in dry sandy soil, Key West, *795*.

Argemone mexicana L.—*Dade Co.:* in dry sandy soil, near Brickell Hammock, Miami, *523*.

TURNERACEAE

Piriqueta caroliniana (Walt.) Urb.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *265;* in everglades along Tamiami Trail, 25 miles west of Miami, *3753*.

Piriqueta glabrescens Small—*Dade Co.:* in dry sandy pineland, Buena Vista, *5813*. *Monroe Co.:* in everglades, Pine Crest, *364*.

Piriqueta tomentosa H.B.K.—*Dade Co.:* in dry sandy soil, Miami, *779a;* in sandy pineland, Miami, *3622;* in dry sandy pineland, Buena Vista, Miami, *5814;* in sandy pineland, Homestead, *5823*.

LOASACEAE

Mentzelia floridana Nutt.—*Broward Co.:* in sand on coastal sand-dunes, Lauderdale Beach, *256*.

CAPPARIDACEAE

Capparis cynophallophora L.—*Lee Co.:* in sand on midden, Coconut, *5781*. *Monroe Co.:* in hammock, Lower Matecumbe Key, *5740*.

Capparis flexuosa L.—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5741*.

MORINGACEAE

Moringa oleifera Lam.—*Dade Co.:* cultivated along roadside, Buena Vista, Miami, *5526;* in cultivation, Coconut Grove, *5758.*

BRASSICACEAE

Cakile lanceolata (Willd.) O. E. Schulz—*Dade Co.:* in sand on coastal sand-dunes Miami Beach, *385;* in sand on coastal sand-dunes, Golden Beach, *399.*

Lepidium virginicum L.—*Dade Co.:* in dry soil along roadside near Brickell Hammock, Miami, *518.*

Senebiera pinnatifida P. DC.—*Leon Co.:* in dry sandy soil along roadside, Tallahassee, *1112.*

Sinapis arvensis L.—*Dade Co.:* in moist rich soil on cultivated land south of Florida City, *825.*

Warea carteri Small—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *273.*

VIOLACEAE

Viola septemloba Le Conte—*Lee Co.:* in dry sandy pineland, Fort Myers, *5889. Sarasota Co.:* in sandy ditch, about 8 miles southeast of Venice, *5916.*

Viola vittata Greene—*Seminole Co.:* in wet ditch about 1½ miles south of Sanford, *183.*

Viola sp.—*Orange Co.:* in wet sandy ditch, about 2 miles east of Fort Christmas, *5383.*

POLYGALACEAE

Asemeia grandiflora (Walt.) Small—*Broward Co.:* in dry sandy pineland, west of Davie, *456. Dade Co.:* in dry sandy soil near Cox Hammock, west of Goulds, *644;* at edge of roadside along Tamiami Trail, 25 miles west of Miami, *3718. Lee Co.:* in dry sandy soil, Bonita Beach, *977.* These collections were all distributed as *Polygala grandiflora* Walt.

Asemeia grandiflora var. *angustifolia* (T. & G.) Small—*Brevard Co.:* in dry sandy soil along roadside about 8 miles west of Melbourne, *227. Broward Co.:* in dry sandy soil, west of Pompano, *475. Dade Co.:* in dry sandy soil west of Goulds, *639;* in dry sandy pineland, Buena Vista, Miami, *5492.* These collections were all distributed as *Polygala grandiflora* var. *angustifolia* T. & G.

Galypola incarnata (L.) Nieuwl.—*Lee Co.:* in dry sandy pineland, Fort Myers, *683,* distributed as *Polygala incarnata.*

Pilostaxis baldwinii (Nutt.) Small—*Dade Co.:* in wet marl, South Miami, *5824. Lee Co.:* in moist sandy soil, west of Fort Myers, *927a;* in moist sandy pineland, Big Pine Island, *941. Monroe Co.:* in everglades, Pine Crest, *649.* Plants with the fragrance of wintergreen; all distributed originally as *Palygala baldwinii* Nutt.

Pilostaxis cymosa (Walt.) Small—*Sarasota Co.:* in sandy bog, about 8 miles southeast of Venice, *1037,* distributed originally as *Polygala cymosa* Walt.

Pilostaxis nana (Michx.) Raf.—*Lee Co.:* in dry sandy pineland, Fort Myers, *687a;* in dry sandy pineland south of Fort Myers, *911.* Both collections originally distributed as *Polygala nana* (Michx.) DC.

Pilostaxis ramosa (Ell.) Small—*Lee Co.:* in wet sandy pineland, west of Fort Myers, *928, 928a;* in moist sandy pineland, Big Pine Island, *942a.* These collections all distributed as *Polygala ramosa* Ell.

Pilostaxis rugelii (Shuttlw.) Small—*Lee Co.:* in moist sandy pineland, south of Fort Myers, *910;* in moist sandy pineland, near Coconut, *965a;* in wet grassy bog, Coconut, *5786. Seminole Co.:* in dry sandy soil about 1½ miles south of Sanford, *5349.* These collections distributed as *Polygala rugelii* Shuttlw.

Polygala boykinii Nutt.—*Lee Co.:* in moist sandy ditch, north of Estero, *960.*

Polygala cruciata L.—*Glades Co.:* in swampy ground, near Citrus Center, *8401. Lee Co.:* in moist grassy ditch, Coconut, *5892.*

Polygala flagellaris Small—*Dade Co.:* in dry sandy pineland, south of Florida

City, *5816*. *Monroe Co.:* in dry sandy soil, Cypress Lodge, Pine Crest, *352*.

Polygala mariana Mill.—*Gulf Co.:* in moist grassy field, south of Dalkeith, *1151*.

Polygala polygama Walt.—*Duval Co.:* in moist sandy field, about 4 miles east of Eastport, *5261*. *Gulf Co.:* in dry sandy soil along roadside, south of Dalkeith, *1149a*. *Pasco Co.:* in dry sandy soil, Hudson, *5932*.

Polygala praetervisa Chod.—*Monroe Co.:* in dry sandy pineland, Big Pine Key, *820a*.

Polygala setacea Michx.—*Lee Co.:* in dry sandy soil among palmettos, Fort Myers, *954*, *974a*. *Orange Co.:* in dry sandy field, about 3 miles west of Bithlo, *5380*.

CRASSULACEAE

Bryophyllum pinnatum (Lam.) S. Kurz—*Dade Co.:* in moist hammock, Little River, *314;* in sandy soil along edge of hammock, Miami, *3677*.

Kalanchoë carnea Mast.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5498*.

Sedum mexicanum Britton—*Leon Co.:* in dry sandy soil along roadside, Tallahassee, *5960*.

DROSERACEAE

Drosera capillaris Poir.—*Lee Co.:* in moist sand along roadside ditch, Coconut, *967a*.

Drosera intermedia Hayne—*Sarasota Co.:* in sandy bog, about 8 miles southeast of Venice, *820*.

Drosera tracyi Macfarlane—*Wakulla Co.:* in wet sand along ditch, south of Sopchoppy, *1127*, originally distributed as "*D. tracyi* (Macfarlane) Small."

SARRACENIACEAE

Sarracenia drummondii Croom—*Gulf Co.:* in grassy bog, north of Apalachicola, *1143*, *1177*.

Sarracenia flava L.—*Calhoun Co.:* in wet grassy bog, south of Myron, *570*. *Gulf Co.:* in grassy bog, south of Dalkeith, *1148*.

Sarracenia minor Walt.—*Baker Co.:* in wet sandy soil, Glen St. Mary, *1176*. *Columbia Co.:* in wet pineland bog, south of Ellisville, *1103*. *Franklin Co.:* in bog, McIntyre, *5967*. *Orange Co.:* in sandy bog, about 3 miles west of Bithlo, *5378*. *Osceola Co.:* in bog, Deer Park, *5406*. *Suwannee Co.:* in wet grassy bog, Houseton, *568;* in wet sandy pineland, Houseton, *1105a*.

Sarracenia psittacina Michx.—*Gulf Co.:* in grassy bog, north of Apalachicola, *1142*, *1226*.

Sarracenia purpurea L.—*Calhoun Co.:* in wet sandy bog Myron, *1158*.

AIZOACEAE

Sesuvium portulacastrum L.—*Duval Co.:* in sand along shore of bay, near Pilottown, *173;* trailing on sand of beach, about 4 miles east of Eastport, *5284*.

ALSINACEAE

Alsine media L.—*Leon Co.:* in waste land, Tallahassee, *1168*.

Stipulicidia setacea Michx.—*Lee Co.:* in dry sandy field, Fort Myers, *915*.

PORTULACACEAE

Portulaca oleracea L.—*Dade Co.:* in waste ground, Coconut Grove, *5692*. *Monroe Co.:* in sand, Lower Matecumbe Key, *764a*, det. Wilson.

Portulaca pilosa L.—*Clay Co.:* in moist sandy soil along roadside, about 2 miles north of Orange Park, *161*.

Talinum triangulare Willd.—*Dade Co.:* in cultivation, Coconut Grove, *5687*.

POLYGONACEAE

Delopyrum gracile (Nutt.) Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami. *308a*. *Orange Co.:* in dry sandy woods, south of Wekiva Springs, *190*.

Eriogonum floridanum Small—*Orange Co.:* in dry sandy soil along edge of woods, south of Wekiva Springs, *191.*

Eriogonum tomentosum Michx.—*Hernando Co.:* in dry sandy woods, southwest of Brooksville, *5935. Jackson Co.:* in dry sandy pineland, Marianna, *5914,* collected by E. T. Wherry. *Polk Co.:* in dry sandy woods, about 2 miles south of Frostproof, *5414.*

Persicaria hydropiperoides (Michx.) Small—*Dade Co.:* in moist soil at edge of hammock, Little River, *441. Duval Co.:* in wet ditch, about 5 miles east of South Jacksonville, *5229. Lake Co.:* in boggy soil along brook through woods, near Astatula, *194. Lee Co.:* in moist soil under bridge, Bonita Springs, *973. Leon Co.:* in wet soil near edge of lake, Tallahassee, *5961. St. Johns Co.:* in wet ditch, near Orange Dale, *5243.*

Persicaria punctata (Ell.) Small—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3814.*

Polygonella brachystachya Meisn.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5815.*

Rumex conglomeratus J. Murray—*Leon Co.:* in moist grassy field, Tallahassee, *1117.*

Rumex hastatulus Muhl.—*Hernando Co.:* in dry sandy soil, north of Aripeka, *1067a;* in dry sandy soil along roadside, Brooksville, *1070.*

Rumex obtusifolius L.—*Leon Co.:* in waste ground, Tallahassee, *1173.*

Rumex verticillatus L.—*Lee Co.:* in swampy soil, Fort Myers, *953.*

Thysanella robusta Small—*Lake Co.:* in dry sandy woods, near Astatula, *194a;* in dry sandy oak woods, north of Mineola, *195.*

COCCOLOBACEAE

Coccolobis laurifolia Jacq.—*Dade Co.:* at edge of hammock, Brickell Hammock, Miami, *5700.*

Coccolobis uvifera (L.) Jacq.—*Dade Co.:* in sand on seashore, Miami Beach, *3651.*

Corculum leptopus (Hook. & Arn.) Stuntz—*Dade Co.:* climbing over low trees in dry sandy field, apparently escaped from cultivation, Miami, *308;* in cultivation, Miami, *3650.* Both collections distributed as *Antigonum leptopus* Hook. & Arn.

CORRIGIOLACEAE

Anychiastrum herniarioides (Michx.) Small—*Lake Co.:* in sandy soil in pine woods, near Tavares, *193.*

PHYTOLACCACEAE

Agdestis clematidea M. & S.— *Dade Co.:* vine climbing up tree in hammock, Miami, *3705.*

Phytolacca rigida Small—*Martin Co.:* in dry sandy soil, about 1 mile north of Fort Mayaca, *250.*

Rivina humilis L.—*Dade Co.:* in moist soil of hammock, Miami, *325;* in brush along edge of hammock, Miami, *3707.*

Trichostigma octandrum H. Walter—*Dade Co.:* in swampy ground along roadside, Miami, *3703.* This genus was by mistake classified in the *Carduaceae* in my "An Annotated and classified list of H. N. Moldenke collection numbers from no. 1 to no. 11,277, inclusive," pages 97 & 133, 1939.

PETIVERIACEAE

Petiveria alliacea L.—*Dade Co.:* in moist soil, Brickell Hammock, Miami, *723;* in damp rich soil at edge of Brickell Hammock, Miami, *727a.*

CHENOPODIACEAE

Ambrina ambrosioides var. *anthelmintica* (L.) Moldenke—*Dade Co.:* in sand near hammock at edge of bay, Brickell Hammock, Miami, *726* [this collection was unintentionally omitted from my Annotated List]. *Okeechobee Co.:* in waste sandy soil near Lake Okeechobee, Okeechobee City, *5433.* Both collections distributed as *Chenopodium anthelminticum* L.

Atriplex cristata H.B.K.—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *576.*

Dondia linearis (Ell.) Heller—*Monroe Co.:* in dry sandy soil at edge of water, Saddlebunch Keys, *813.*

Salicornia ambigua Michx.—*Duval Co.:* in sand on beach, about 4 miles east of Eastport, *5285.*

Salicornia bigelovii Torr.—*Monroe Co.:* in moist sandy soil, Lower Matecumbe Key, *761.*

AMARANTHACEAE

Achyranthes aspera L.—*Monroe Co.:* in dry sandy waste soil, Key West, *790.*

Acnida cuspidata Bertero—*Dade Co.:* in rich moist soil near cultivated ground, Little River, *531.*

Acnida floridana S. Wats.—*Lee Co.:* in sandy soil, Crescent Beach, *6489*, collected by W. M. Buswell.

Alternanthera floridana (Chapm.) Small—*Broward Co.:* in sand on coastal sand-dunes, Lauderdale Beach, *246a.*

Alternanthera maritima J. St. Hil.—*Dade Co.:* in sand near shore of Bay Biscayne, Buena Vista, Miami, *290.*

Alternanthera ramosissima Mart.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3717.*

Amaranthus gracilis Desf.—*Dade Co.:* in dry sandy waste soil along roadside, Buena Vista, Miami, *716.*

Amaranthus hybridus L.—*Dade Co.:* in dry sandy waste soil, Buena Vista, Miami, *5708.*

Amaranthus retroflexus L.—*Broward Co.:* in rich soil on prairies along the Pine Island road west of Davie, *499.*

Amaranthus spinosus L.—*Dade Co.:* in waste soil, Buena Vista, Miami, *325a;* in waste soil along roadside, Buena Vista, Miami, *326;* in waste ground, Miami, *3704. Duval Co.:* in waste ground, South Jacksonville, *5257.*

Comphrena decumbens Jacq.—*Orange Co.:* in sandy woods, south of Wekiva Springs, *187. Pinellas Co.:* in dry sandy soil along roadside, near Dunedin, *1058.*

Iresine celosia L.—*Dade Co.:* in waste ground along Tamiami Trail, 25 miles west of Miami, *3716.*

Iresine paniculata (L.) Kuntze—*Martin Co.:* in dry soil along roadside near canal about 1 mile north of Fort Mayaca, *248. Orange Co.:* in dry sandy soil along roadside, about 2 miles east of Fort Christmas, *214.*

Philoxerus vermicularis (L.) R. Br.—*Monroe Co.:* in dry soil at edge of road, north end of Key Largo, *411.*

Telanthera versicolor Regel—*Dade Co.:* in cultivation, Miami, *3706.*

LINACEAE

Cathartolinum carteri Small—*Collier Co.:* in dry sandy soil along Tamiami Trail, *657. Dade Co.:* in dry sandy marl, Goulds, *741;* in waste ground, Coconut Grove, *5696;* in sandy marl, Goulds, *5737.*

Cathartolinum curtissii Small—*Collier Co.:* in moist sandy pineland along old Tamiami Trail, *982.*

Cathartolinum floridanum (Planch.) Small—*St. Johns Co.:* in dry sandy woods, near Sampson, *5292.*

ZYGOPHYLLACEAE

Guaiacum sanctum L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5726. Monroe Co.:* at edge of hammock, Lower Matecumbe Key, *5743.*

Kallstroemia maxima (L.) T. & G.—*Monroe Co.:* in dry sandy waste ground, Key West, *791;* in dry sandy soil along roadside, Key West, *792.*

GERANIACEAE

Geranium carolinianum L.—*Leon Co.:* in dry sandy soil along roadside, Tallahassee, *807.*

OXALIDACEAE

Averrhoa carambola L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5729.*

Xanthoxalis brittoniae Small—*Hendry Co.:* in moist ditch, Labelle, *1020.*

LYTHRACEAE

Ammania latifolia L.—*Dade Co.:* in everglades at edge of canal along Tamiami Trail, 25 miles west of Miami, *3720. Monroe Co.:* in moist sandy soil, Pine Crest, *358.*

Lythrum vulneraria Ait.—*Lee Co.:* in moist sandy ditch along roadside, Rialto, *1011a.*

Parsonsia lythroides Small—*Gulf Co.:* in dry sandy soil along roadside, south of Dalkeith, *1154.*

PUNICACEAE

Punica granatum L.—*Dade Co.:* escaped from cultivation along roadside, Miami, *3649.*

OENOTHERACEAE

Gaura angustifolia Michx.—*Duval Co.:* in dry sandy field, South Jacksonville, *170,* distributed as *G. michauxii* Spach.

Gaura angustifolia var. *eatonii* (Small) Munz—*Lee Co.:* in dry sandy soil, Fort Myers, *789,* det. Munz; in dry sandy soil west of Fort Myers, *917,* det. Munz; in dry sandy pineland, Salvista, *1032a,* det. Munz. These three collections were distributed as *G. eatonii* Small.

Gaura angustifolia var. *simulans* (Small) Munz—*Dade Co.:* in dry sandy soil, Miami Beach, *584,* det. Munz, distributed as *G. simulans* Small; in sandy soil along roadside, Buena Vista, Miami, *5484,* distributed as *G. simulans* Small. *Lee Co.:* in dry sandy soil west of Buckingham, *1008,* det. Munz, distributed as *G. michauxii* Spach.

Hartmannia speciosa (Nutt.) Small— *Pasco Co.:* in dry sandy soil, New Port Richey, *1063.*

Isnardia intermedia Small—*Collier Co.:* in wet sandy ditch, Turner's River Hammock, *671.*

Isnardia repens (Sw.) P. DC.—*Monroe Co.:* in shallow water of everglades, Pine Crest, *864.*

Jussiaea leptocarpa Nutt.—*Brevard Co.:* in sandy bog, near Melbourne, *5403. Duval Co.:* in marshy ground, South Jacksonville, *8078.*

Jussiaea peruviana L. —*Dade Co.:* at edge of canal, southwest of Tamiami Trail, *338a,* distributed as "*J. peruviana* Nutt." *Lee Co.:* in wet soil at brook near Bonita Beach, *980. Monroe Co.:* at edge of canal, Cypress Lodge, Pine Crest, *343,* distributed as "*J. peruviana* Nutt." *Seminole Co.:* in wet acid soil by brook, about 1½ miles south Sanford, *186.*

Jussiaea scabra Willd.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3719. Monroe Co.:* at edge of canal, Cypress Lodge, Pine Crest, *344. Orange Co.:* in dry sandy soil, Orlando, *5325.*

Kneiffia arenicola Small—*Madison Co.:* in dry sandy woods, Ellaville, *1106.*

Kneiffia sp.—*Franklin Co.:* in dry sandy soil, Carrabelle, *5968.*

Ludwigia curtissii Chapm.—*Lee Co.:* in wet sandy ditch, Fort Myers, *685. Monroe Co.:* in dry sandy soil, Pine Crest, *856a.*

Ludwigia microcarpa Michx.—*Collier Co.:* in moist soil, Turner's River Hammock, *664a. Monroe Co.:* in dry sandy soil, Pine Crest, *648.*

Ludwigia virgata Michx.—*Dade Co.:* in dry sandy pineland, Uleta, *891.*

Raimannia humifusa (Nutt.) Rose—*Sarasota Co.:* in dry sandy soil, about 8 miles southeast of Venice, *1038* [this collection was unintentionally omitted from my Annotated List]. *Volusia Co.:* in sand on dunes, Mosquito Inlet, *5306*

Raimmania laciniata (Hill) Rose—*Duval Co.:* in dry sandy soil, South Jacksonville, *169;* in dry sandy soil about 5 miles east of South Jacksonville, *5226. Hernando Co.:* in dry sandy woods, Brooksville, *1074. Pinellas Co.:* in dry sandy soil, Dunedin, *5926.*

HALORRHAGIDACEAE

Proserpinaca pectinata Lam.—*Lee Co.:* in wet ditch, Fort Myers, *5776.*

Proserpinaca platycarpa Small—*Monroe Co.:* in wet lime-sink in everglades, Pine Crest, *363.*

NYCTAGINACEAE

Boerhaavia caribaea Jacq.—*Collier Co.:* in dry sandy ditch, north of Caxambas, *608;* in dry sandy soil along roadside, Caxambas, *1002.* Both collections were distributed as *B. hirsuta* L.

Boerhaavia decumbens Vahl—*Dade Co.:* in dry sandy soil along roadside, Miami, *775.*

Boerhaavia erecta L.—*Volusia Co.:* in sand on dunes, Daytona Beach, *5298;* in sand on dunes, Mosquito Inlet, *5304.*

Boerhaavia sp.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5530.*

Bougainvillea glabra Choisy—*Dade Co.:* in cultivation along fence, Miami, *3586.*

PISONIACEAE

Pisonia aculeata L.—*Dade Co.:* in dense hammock, Snapper Creek, *733a. Monroe Co.:* in hammock, north end of Key Largo, *415a;* in hammock, Cape Sable region, *832.*

Torrubia longifolia (Heimerl) Britton—*Dade Co.:* in sandy pineland, Brickell Hammock, Miami, *5620.*

PROTEACEAE

Grevillea robusta Cunn.—*Orange Co.:* in cultivation along roadside, Orlando, *5373. Pasco Co.:* persistent after cultivation, Elfers, *5929.*

PITTOSPORACEAE

Pittosporum tobira Ait.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5719.*

FLACOURTIACEAE

Flacourtia indica (Burm. f.) Merr.—*Dade Co.:* in dry grassy lot, apparently escaped from cultivation, Buena Vista, Miami, *526a, 799;* in grassy lot, naturalized after cultivation, Buena Vista, Miami, *839;* at edge of mangrove swamp near Bay Biscayne, Buena Vista, Miami, *5652;* in cultivation, Buena Vista, Miami, *5829.* The species is not recorded in Small's Manual.

Myroxylon ellipticum (Clos) Kuntze—*Dade Co.:* in cultivation, Coconut Grove, *5672.*

CANELLACEAE

Canella winterana (L.) Gaertn.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5848.*

CISTACEAE

Crocanthemum carolinianum (L.) Spach—*Hernando Co.:* in sandy pine woods, Brooksville, *1080.*

Crocanthemum corymbosum (Michx.) Britton—*Broward Co.:* in dry sandy pineland, Hollywood, *599. Hernando Co.:* in dry sandy pine woods, Brooksville, *1080a. Lee Co.:* in dry sandy pineland, west of Fort Myers, *926;* in dry sandy pineland, Big Pine Island, *931a. Okeechobee Co.:* in dry sandy pineland, Okeechobee City, *5424. Osceola Co.:* in water at edge of bog, Deer Park, *5409a.*

Crocanthemum sp.—*Brevard Co.:* in dry sandy field, near Melbourne, *5393.*

Lechea patula Leggett—*Dade Co.:* in dry sandy pineland, west of Fulford, *5662.*

PASSIFLORACEAE

Passiflora incarnata L.—*Orange Co.:* along roadside, south of Wekiva Springs, *5357.*

Passiflora laurifolia L.—*Dade Co.:* in cultivation, Coconut Grove, *5677,* det. Bailey.

Passiflora multiflora L.—*Monroe Co.:* climbing over shrubs in hammock, north end of Key Largo, *404*, det. Killip.

Passiflora sexflora A. Juss.—*Dade Co.:* climbing over shrubs, Lewis-Nixon Hammock, Redlands district, *550*, det. Killip, *552a*, det. Killip.

Passiflora suberosa L.—*Dade Co.:* climbing over low shrubs in dry sandy soil, Buena Vista, Miami, *323*, det. Killip; climbing over weeds on canal embankment, east of Big Bend along Tamiami Trail, *340*, det. Killip; in dry grassy field near Brickell Hammock, Miami, *516*, det. Killip; climbing over weeds in dry grassy field near Brickell Hammock, Miami, *517*, det. Killip; climbing over weeds, Buena Vista, Miami, *526*, det. Killip; climbing over bushes in moist soil, Lewis-Nixon Hammock, Redlands district, *550a*, det. Killip; trailing at edge of canal along Tamiami Trail, 25 miles west of Miami, *3764*, det. Killip.

CUCURBITACEAE

Citrullus vulgaris Schrad.—*Duval Co.:* trailing on dry sandy soil along roadside, about 4 miles east of Eastport, *5275*.

Citrullus vulgaris var. *citroides* L. H. Bailey—*Dade Co.:* escaped along roadside, Miami Beach, *5653*.

Luffa cylindrica (L.) Roem.—*Dade Co.:* in cultivation, Miami, *1791*.

Melothria crassifolia Small—*Dade Co.:* trailing in muck at edge of canal along Tamiami Trail, 25 miles west of Miami, *3780*. *Highlands Co.:* in dry sandy soil along roadside, near Childs, *242*.

Momordica charantia L.—*Martin Co.:* climbing over roadside weeds, about 1 mile north of Fort Mayaca, *249*.

CARICACEAE

Carica papaya L.—*Dade Co.:* escaped from cultivation in waste ground, Miami, *3676*. *Monroe Co.:* in hammock, north end of Key Largo, *409*.

CACTACEAE

Harrisia simpsonii Small—*Monroe Co.:* in hammock, Cape Sable region, *5861*.

Hylocereus tricostatus (Gosselin) Britton & Rose—*Monroe Co.:* in hammock, Upper Matecumbe Key, *5832*.

Opuntia austrina Small—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *373a;* in pineland, Miami, *3612*. *Lee Co.:* in dry sandy pineland, Fort Myers, *5791*.

Opuntia compressa (Salisb.) F. Macbr. —*Duval Co.:* in sand near water, about 4 miles east of Eastport, *5280*.

Opuntia dillenii (Ker) Haw.—*Lee Co.:* in sand on coastal sand-dunes, Bokeelia, *938*. *Monroe Co.:* in dry sandy waste ground, Key West, *5840*.

Opuntia drummondii R. Grah.—*Lee Co.:* in dry sandy pineland, Fort Myers, *956*.

Opuntia inermis P. DC.—*Monroe Co.:* in hammock, Key Largo, *5820*.

Opuntia pes-corvi Le Conte—*Lake Co.:* in dry sandy woods, near Astatula, *5369*.

Opuntia vulgaris Mill.—*Duval Co.:* in sand on dunes, Florida Beach, *5233*.

THEACEAE

Camellia sasanqua Thunb.—*Orange Co.:* in cultivation, Orlando, *5323*.

MYRTACEAE

Anamomis dicrana (Berg.) Britton—*Dade Co.:* along roadside, Miami, *3349*, collected by J. K. Small.

Anamomis longipes Britton—*Dade Co.:* in dry sandy marl, Seminole Plains, Black Point, *419b*.

Anamomis simpsonii Small—*Dade Co.:* in hammock west of Fulford, *5574*.

Eucalyptus globulus Labill.—*Manatee Co.:* along roadside, south of Cates City, *5920*.

Eucalyptus robusta J. E. Sm.—*Okeechobee Co.:* at edge of roadside, Okeechobee City, *5420*. *Volusia Co.:* at edge of thicket, near Ariel, *5318*.

Eugenia axillaris (Sw.) Willd.—*Lee Co.:* on kitchen-midden, Coconut, *5783.*

Eugenia buxifolia (Sw.) Willd.—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5746.*

Eugenia confusa P. DC.—*Dade Co.:* in Brickell Hammock, Miami, *5632, 5699,* det. Wilson, originally distributed as *E. buxifolia* (Sw.) Willd.

Eugenia jambos L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5639.*

Eugenia uniflora L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5457;* escaped from cultivation in vacant lot, Buena Vista, Miami, *5482.*

Melaleuca leucadendron L.—*Dade Co.:* escaped from cultivation in sandy soil, Miami, *3591.*

Psidium cattleianum Sabine—*Lee Co.:* in dry sandy waste ground, apparently escaped from cultivation, East Fort Myers, *985.*

Psidium guajava L.—*Dade Co.:* in overgrown deserted citrus orchard, Buena Vista, Miami, *288;* in cultivation, Miami, *3688;* in cultivation, Buena Vista, Miami, *5557,* distributed as "*P. guajava* Raddi." *Okeechobee Co.:* in overgrown woods, Okeechobee City, *5436.*

MELASTOMACEAE

Rhexia lutea Walt.—*Baker Co.:* in wet sandy soil of grassy bog, Glen St. Mary, *1175. Calhoun Co.:* in wet grassy bog, Myron, *1158a.*

Rhexia mariana L.—*Collier Co.:* in moist sandy ditch along old Tamiami Trail, *5899.*

Tetrazygia bicolor (Mill.) Cogn.—*Dade Co.:* in dry sandy pineland, Homestead, *774;* at edge of Hattie Bauer Hammock, Redlands district, *5646.*

COMBRETACEAE

Bucida buceras L.—*Dade Co.:* in cultivation, Little River, *5734.*

Conocarpus erecta L.—*Broward Co.:* in dry sandy soil, Dania Beach, *597. Dade Co.:* in dry sandy soil along beach, Miami Beach, *377;* in swamp at Bay Biscayne, Buena Vista, Miami, *5483.*

Conocarpus erecta var. *sericea* P. DC.—*Monroe Co.:* in wet sandy soil, Upper Matecumbe Key, *605;* in hammock, Key Largo, *5583,* collected by C. A. Mosier.

Laguncularia racemosa (L.) Gaertn. f.—*Broward Co.:* in swamp, Lauderdale Beach, *5445a. Dade Co.:* in wet swampy soil, Miami, *3690.*

Terminalia catappa L.—*Dade Co.:* at edge of Brickell Hammock, Miami, *5621;* escaped from cultivation, Brickell Hammock, *5625.*

RHIZOPHORACEAE

Rhizophora mangle L.—*Broward Co.:* in mangrove swamp, Dania Beach, *596.*

HYPERICACEAE

Ascyrum hypericoides L.—*Hendry Co.:* in moist sandy soil, Labelle, *1019. Monroe Co.:* in moist sandy soil, Pine Crest, *365. Orange Co.:* in dry sandy soil, Orlando, *5332.*

Ascyrum stans Michx.—*Orange Co.:* in dry sandy field, about 3 miles west of Bithlo, *5379. Seminole Co.:* in dry sandy soil, about 3 miles south of Sanford, *5347.*

Ascyrum tetrapetalum (Lam.) Vail—*Clay Co.:* in dry sandy soil along roadside, about 2 miles north of Orange Park, *160. Dade Co.:* along roadsides, west of Fulford, *5660. Lee Co.:* in dry sandy soil along roadside near Coconut, *969.*

Crookca microsepala (T. & G.) Small—*Gulf Co.:* in moist sandy soil along roadside, Port St. Joe, *1147a. Jackson Co.:* in dry sandy woods, east of Marianna, *1161.*

Hypericum aspalathoides Willd.—*Broward Co.:* in moist sand, west of Davie, *455a;* in moist sandy soil, west of Pompano, *463. Lee Co.:* in dry sandy soil near Coconut, *965;* in dry sandy pineland, Bonita Beach, *973a. St. Johns Co.:* in dry sandy woods near Sampson, *5293.*

Hypericum cestrifolium Lam.—*Clay Co.:* in moist sandy soil, about 2 miles north

of Orange Park, *160a. Collier Co.:* in everglades, south of Tamiami Trail, *878. St. Johns Co.:* in wet sandy ditch, near Sampson, *175a.* These three collections were distributed as *H. opacum* T. & G.

Hypericum densiflorum Pursh—*Duval Co.:* in dry sandy soil along roadside, about 5 miles east of South Jacksonville, *5224.*

Hypericum fasciculatum Lam.—*Baker Co.:* in grassy field, Glen St. Mary, *5983a. Gulf Co.:* in moist sandy soil, north of Apalachicola, *1146. Orange Co.:* in dry sandy soil, Orlando, *5326. Osceola Co.:* in dry sandy soil along roadside, east of Kissimmee, *238.*

Hypericum mutilum L.—*St. Johns Co.:* in wet sandy ditch, near Sampson, *175.*

Sarothra gentianoides L.—*Calhoun Co.:* in moist ditch, south of Myron, *5974.*

CLUSIACEAE

Mammea americana L.— *Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3749.*

TILIACEAE

Corchorus siliquosus L.—*Monroe Co.:* in dry sandy soil, Cypress Lodge, Pine Crest, *345.*

Triumfetta semitriloba Jacq.—*Dade Co.:* in dry waste ground near edge of everglades, Miami, *3691.*

ELAEOCARPACEAE

Eleaocarpus dentatus Vahl—*Dade Co.:* in cultivation, Coconut Grove, *5670.*

STERCULIACEAE

Dombeya wallichii Benth. & Hook.—*Dade Co.:* in cultivation, Miami, *3631.*

Firmiana simplex Wight—*Columbia Co.:* in cultivation, Lake City, *5957.*

Guazuma tomentosa H.B.K.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3781.*

Riedlea glabrescens (Presl) Small—*Collier Co.:* in dry sandy pineland, Old Tamiami Trail, *5897. Lee Co.:* in dry sandy pinleand, Fort Myers, *1358a,* collected by W. M. Buswell.

Waltheria americana L.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3750. Monroe Co.:* in everglades at edge of road, Pine Crest, *362;* in dry sandy soil, Upper Matecumbe Key, *767;* sprawling shrub in waste ground, Key West, *5841.*

BOMBACACEAE

Bombax ceiba L.—*Dade Co.:* in cultivation, Coconut Grove, *5673.*

Chorisia speciosa St.-Hil.—*Lee Co.:* in cultivation, Fort Myers, *5888.*

Pachira fastuosa Decaisne—*Dade Co.:* in cultivation, Buena Vista, Miami, *5723.*

MALVACEAE

Abutilon permolle (Willd.) Sweet—*Monroe Co.:* in hammock, Key Largo, *606;* in sandy soil, Key Largo, *771.*

Ceinfuegosia heterophylla (Vent.) Garcke—*Monroe Co.:* in dry sandy soil, Lower Matecumbe Key, *619.*

Gayoides crispum (L.) Small—*Monroe Co.:* in dry sandy soil along roadside, Key Largo, *613;* in dry soil along roadside, Islamorada Key, *621a.*

Gossypium hirsutum L.—*Monroe Co.:* in dry hammock, Lower Matecumbe Key, *621.*

Hibiscus rosa-sinensis L.—*Dade Co.:* in cultivation, Miami, *3693;* escaped along roadside, Buena Vista, Miami, *5447. Monroe Co.:* in moist sandy waste ground, apparently escaped from cultivation, Key West, *890.*

Kosteletzkya althaeifolia (Chapm.) A. Gray—*Broward Co.:* in dry sandy soil on canal embankment, west of Pompano, *468. Dade Co.:* in sand along canal embankment, Buena Vista, Miami, *5488.*

Kosteletzkya virginica (L.) A. Gray—*Broward Co.:* in moist sandy soil west of

Hollywood, *592a. Dade Co.:* in dry sandy soil along Tamiami Trail, about 15 miles west of Miami, *371b;* in wet sandy ditch, west of Fulford, *5658. Monroe Co.:* in moist sandy soil, Cape Sable region, *835.*

Lavatera arborea L.—*Dade Co.:* in cultivation, Miami, *3692.*

Malachra alceifolia Jacq.—*Monroe Co.:* in dry sandy soil, near Pine Crest, *367a.*

Malvastrum corchorifolium (Desr.) Britton—*Monroe Co.:* in dry sandy soil along roadside, Cape Sable region, *834.*

Malvaviscus grandiflorus H.B.K.—*Dade Co.:* in cultivation, Miami, *3581.*

Malvaviscus penduliflorus P. DC.—*Lee Co.:* in sandy soil along roadside, apparently escaped from cultivation, East Fort Myers, *993,* distributed as *M. grandiflorus* H.B.K.

Modiola caroliniana (L.) G. Don—*Leon Co.:* in dry sandy soil along roadside, Tallahassee, *1114;* in sandy waste ground, Tallahassee, *1115a.*

Paritium abutiloides G. Don—*Dade Co.:* in cultivation, Buena Vista, Miami, *5724.*

Paritium elatum Sw.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5714.*

Sida carpinifolia L. f.—*Brevard Co.:* in dry sandy soil, Merritt's Island, *5388. Dade Co.:* in dry sandy soil along railroad, Buena Vista, Miami, *269, 706, 707;* in dry sandy waste ground, Little River, *529a;* in dry sandy pineland, Miami, *712a. Glades Co.:* in dry sandy soil, Moore Haven, *1029. Jackson Co.:* in field, Marianna, *8345. St. Johns Co.:* in waste ground, St. Augustine, *5251.*

Sida cordifolia L.—*Lee Co.:* in dry sandy soil, Estero, *699a.*

Sida elliottii T. & G.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5550.*

Sida rhombifolia L.—*Lee Co.:* along roadside, Fort Myers, *10380.*

Sida spinosa L.—*Dade Co.:* in waste ground, Miami, *3632.*

Thespesia populnea (L.) Soland.—*Dade Co.:* in cultivation, Brickell Hammock, Miami, *5635.*

Urena lobata L.—*Brevard Co.:* in dry sandy soil, Merritt's Island, *215. Broward Co.:* in dry sandy pineland, west of Hollywood, *600. Orange Co.:* in dry sandy woods, about 3 miles north of Winter Park, *5343.*

MALPIGHIACEAE

Byrsonima lucida (Sw.) P. DC.—*Dade Co.:* in dry sandy marl, Goulds, *397.*

EUPHORBIACEAE

Acalypha wilkesiana Muell. Arg.—*Dade Co.:* in dry sandy soil, escaped from cultivation, Miami, *886;* in cultivation, Miami, *3790;* in cultivation, Buena Vista, Miami, *5490.*

Acalypha wilkesiana var. *marginata* W. Mill.—*Dade Co.:* in cultivation, Miami, *3582.*

Aleurites moluccana Willd.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5566.*

Antidesma nitidum Tul.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5853.*

Bischofia trifoliata Hook.—*Dade Co.:* in hammock, Brickell Hammock, Miami, *7363.*

Bivonea stimulosa (Michx.) Raf.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *302a;* in sand on coastal sand-dunes, Miami Beach, *387;* in sandy soil, Miami, *3680. Orange Co.:* in dry sandy soil, Orlando, *5331.* These four collections were distributed as *Cnidoscolus stimulosus* (Michx.) Engelm. & Gray.

Breynia nivosa (W. J. Sm.) Small—*Dade Co.:* in cultivation, Buena Vista, Miami, *5470.*

Chamaesyce blodgettii (Engelm.) Small—*Collier Co.:* in dry sandy soil along roadside, south of Tamiami Trail, *869. Dade Co.:* in dry sandy soil at beach, Miami Beach, *390;* in dry sandy pineland, Buena Vista, Miami, *5651. Monroe Co.:* in dry sandy soil, Upper Matecumbe Key, *765;* in dry sandy soil, Lower Matecumbe Key, *784;* in dry sandy soil, Pine Crest, *853;* in dry sandy waste ground, Key West, *5838.*

Chamaesyce brasiliensis (Lam.) Small—*Dade Co.:* in dry sandy soil, Buena Vista, *328;* in waste ground, Miami, *3578.*

Chamaesyce buxifolia (Lam.) Small—*Broward Co.:* in sand on coastal sand-dunes, Lauderdale Beach, *263a. Dade Co.:* in sandy soil, Miami, *3789. Monroe Co.:* in dry sandy soil along roadside, Key Largo, *402;* in dry sandy waste soil, Key West, *5845.*

Chamaesyce deltoidea (Engelm) Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *291.*

Chamaesyce glomerifera Millsp.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *330;* in sandy field, Miami, *3678. Jackson Co.:* along edge of ditch, Marianna, *8344.* These three collections were distributed and cited in my Annotated List as *C. hypericifolia* (L.) Small.

Chamaesyce hirta (L.) Millsp.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *283.*

Chamaesyce hirta var. *procumbens* (P. DC.) Moldenke—*Monroe Co.:* in dry sandy soil along roadside, Pine Crest, *865,* distributed and cited in my Annotated Lis as *C. gemella* (Lag.) Small.

Chamaesyce hyssopifolia (L.) Small—*Duval Co.:* in dry sandy field, about 5 miles east of South Jacksonville, *5232. Hendry Co.:* in dry sandy soil along roadside, Labelle, *5911.* These two collections were distributed as *C. brasiliensis* (Lam.) Small.

Chamaesyce mathewsii Small—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *577,* distributed originally as *C. dewinkeleri* Small.

Chamaesyce pergamena Small—*Dade Co.:* in dry sandy pineland, Miami, *5827.*

Chamaesyce polygonifolia (L.) Small—*Volusia Co.:* in sand along roadside, Mosquito Inlet, *5301.*

Chamaesyce sp.—*Collier Co.:* in dry sandy waste soil, Caxambas, *5905. Duval Co.:* in dry sandy soil about 4 miles east of Eastport, *5274. Orange Co.:* in dry sandy woods, south of Wekiva Springs, *5351. Pinellas Co.:* in dry sandy soil along roadside, St. Petersburg, *5925.*

Codiaeum variegatum Blume—*Dade Co.:* in cultivation, Miami, *3679;* in cultivation, Buena Vista, Miami, *5493.*

Codiaeum variegatum var. *crispum* Muell. Arg.—*Dade Co.:* in cultivation, Miami, *3613.*

Codiaeum variegatum var. *disraeli* Hort.—*Dade Co.:* in cultivation, Miami, *3615.*

Codiaeum variegatum var. *elegantissimum* Hort.—*Dade Co.:* in cultivation, Miami, *3614.*

Croton argyranthemum Michx.—*Hernando Co.:* in dry sandy woods, southwest of Brooksville, *1068. Lake Co.:* in dry sandy oak woods, north of Mineola, *198.*

Croton fergusonii Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *312, 566a;* in sandy pineland, Miami, *3682.*

Croton glandulosus L.—*Dade Co.:* in dry sandy soil, Little River, *478.*

Croton linearis Jacq.—*Dade Co.:* in dry sandy pineland, Buena Vista, *267;* in waste ground, Miami, *3577.*

Croton punctatus Jacq.—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *311. Volusia Co.:* in sand on dunes, Mosquito Inlet, *5302.*

Ditaxis blodgettii (Torr.) Pax—*Dade Co.:* Brickell Hammock, Miami, *520.*

Drypetes diversifolia Krug & Urb.—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5745.*

Drypetes lateriflora (Sw.) Krug & Urb.—*Dade Co.:* in Brickell Hammock, Miami, *519.*

Euphorbia tirucalli L.—*Dade Co.:* in cultivation along sidewalk, Miami, *3626.*

Galarhoeus inundatus (Torr.) Small—*Calhoun Co.:* in dry sandy soil, south of Myron, *5975,* distributed as *Tithymalus inundatus* (Torr.) Small.

Galarhoeus trichotomus (H.B.K.) Small—*Monroe Co.:* in dry sandy soil along

roadside, Boca Chica Key, *811; in* dry sandy soil, Cudjoe Key, *814a*. These two collections were distributed as *Tithymalus trichotomus* (H.B.K.) Kl. & Garcke.

Gymnanthes lucida Sw.—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5747, 5748*.

Hura crepitans L.—*Dade Co.:* in cultivation, Miami, *3627, 5617*.

Jatropha curcas L.—*Lee Co.:* in cultivation on Edison estate, Fort Myers, *6487*, collected by W. M. Buswell.

Manihot utilissima Pohl—*Dade Co.:* in cultivation, Coconut Grove, *5681*.

Phyllanthus garberi Small—*Volusia Co.:* in sand on dunes, Mosquito Inlet, *5300*.

Phyllanthus nummulariaefolius Poir.—*Orange Co.:* in dry soil on waste ground, Orlando, *181*, det. Croizat. First record for this species from the United States.

Poinsettia cyathophora (J. Murray) Small—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *293a. Duval Co.:* in moist sandy ditch, South Jacksonville, *171*.

Poinsettia heterophylla (L.) Small—*Dade Co.:* in waste ground, Miami, *3792. Okeechobee Co.:* in dry sandy soil, Okeechobee City, *257*.

Poinsettia pinetorum Small—*Dade Co.:* in dry sandy soil near Bay Biscayne, Buena Vista, Miami, *293;* in dry sandy soil, Buena Vista, Miami, *573a;* in waste ground, Miami, *3681*.

Stillingia angustifolia (Torr.) S. Wats.—*Dade Co.:* in dry sandy pineland, Goulds, *540;* in waste ground, Miami, *3630*.

Stillingia aquatica Chapm.—*Gulf Co.:* in moist ditch at edge of woods, south of Dalkeith, *1152*.

Stillingia spathulata (Muell. Arg.) Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *298;* in dry sandy pineland, west of Fulford, *5570*.

Stillingia sylvatica L.—*Columbia Co.:* in dry sandy woods, north of High Springs, *1102. Marion Co.:* in dry sandy woods, Irvine, *5952*.

Stillingia tenuis Small—*Collier Co.:* in wet sandy soil, East Naples, *906;* in wet sandy soil, Tamiami Trail, *5793. Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *572a*.

Tithymalopsis polyphylla (Engelm.) Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5799*.

Tithymalus smallii (Millsp.) Small—*Dade Co.:* at edge of hammock, Cox Hammock, west of Goulds, *645;* in cultivation as hedge, Miami, *3625;* escaped in waste ground, Buena Vista, Miami, *5522*. These three collections were distributed as *Pedilanthus tithymaloides* (L.) Poit.

Tragia linearifolia Ell.—*Dade Co.:* in dry sandy pineland, South Miami, *5857*.

Triadica sebifera (L.) Small—*Lee Co.:* in cultivation, East Fort Myers, *5902*, distributed as *Sapium sebiferum* (L.) Roxb.

ITEACEAE

Itea virginica L.—*Broward Co.:* in moist hammock, west of Pompano, *474*.

ROSACEAE

Rosa bracteata Wendl.—*Lee Co.:* in dry sandy field, apparently escaped from cultivation, East Fort Myers, *983*.

Rosa floridana Rydb.—*Leon Co.:* in dry sandy thicket at edge of woods, Tallahassee, *1169*, det. Rydberg.

Rubus cuneifolius Pursh—*Levy Co.:* in dry sandy soil at edge of woods, south of Morriston, *1082*, det. Rydberg.

Rubus trivialis Michx.—*Collier Co.:* in moist soil, Turner's River Hammock, *669*, det. Rydberg. *Leon Co.:* in sandy waste ground, Tallahassee, *5983*.

MALACEAE

Crataegus aduncа Beadle—*Hernando Co.:* in woods, Brooksville, *5940*.

Crataegus croomiana Sarg.—*Leon Co.:* in dry sandy thicket, Tallahassee, *1119b*, det. Rehder.

Crataegus marshallii Egglest.—*Hernando Co.:* in dry open woodland, Brooksville, *5949*.

Eriobotrya japonica Lindl.—*Orange Co.:* in cultivation, Orlando, *5322*.

AMYGDALACEAE

Chrysobalanus icaco L.—*Broward Co.:* at edge of hammock, west of Davie, *5577*. *Martin Co.:* along roadside, about 1 mile north of Fort Mayaca, *5442*.

Chrysobalanus interior Small—*Collier Co.:* in wet hammock, south of Tamiami Trail, *871* [this collection was unintentionally omitted from my Annotated List]. *Dade Co.:* in dry sandy pine woods, south of Florida City, *751*. Both these collections were originally distributed as *C. pellocarpus* Mey.

Geobalanus oblongifolius (Michx.) Small—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *333;* in dry sandy pineland, Buena Vista, Miami, *5463*, *5467*.

Geobalanus pallidus Small—*Lee Co.:* in dry sandy soil at edge of road, north of Estero, *961*.

Prunus umbellata Ell.—*Dade Co.:* in dry sandy orchard, Homestead, *776*, det. Rehder.

CAESALPINIACEAE

Adipera bicapsularis (L.) Britton & Rose—*Dade Co.:* in dry soil, Miami, *446a*, collected by C. A. Mosier, det. Britton.

Bauhinia galpini N. E. Br.—*Dade Co.:* in cultivation, Miami, *3595*.

Bauhinia heterophylla Kunth—*Dade Co.:* in cultivation, Little River, *5732*.

Bauhinia tomentosa L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5712*.

Bauhinia vahlii Wight & Arn.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5722*.

Bauhinia variegata L.—*Dade Co.:* in cultivation, Coconut Grove, *5618*.

Cassia nodosa Buch.-Ham.—*Dade Co.:* in cultivation, Coconut Grove, *5685*.

Cercis canadensis L.—*Leon Co.:* in woodland, Tallahassee, *5979*.

Chamaecrista brachiata Pollard—*Collier Co.:* in dry sandy soil, Caxambas, *998*. *Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *280;* in dry sandy pineland, Homestead, *401a;* in sandy field, Miami Beach, *3661*.

Chamaecrista simpsonii Pollard—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5757*.

Chamaesenna didymobotrya (Forsk.) Small—*Dade Co.:* in waste ground, apparently escaped from cultivation, Miami, *429*, det. Britton, distributed as *Cassia didymobotrya* Forsk.

Chapmania floridana T. & G.—*Charlotte Co.:* in dry sandy pine woods, Punta Gorda, *1033*. *Sarasota Co.:* in dry sandy soil along roadside, about 8 miles southeast of Venice, *1034a*.

Delonix regia (Boj.) Raf.—*Dade Co.:* in cultivation, Miami, *3660*, distributed as *Poinciana regia* Bojer.

Ditremexa ligustrina (L.) Britton & Rose—*Dade Co.:* in dry sandy soil at edge of canal, along Tamiami Trail, *897*, det. Britton.

Ditremexa occidentalis (L.) Britton & Rose—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *285a*, det. Britton. *Okeechobee Co.:* along roadside, Okeechobee City, *5423*. These two collections distributed as *Cassia occidentalis* L.

Emelista tora (L.) Britton & Rose—*Collier Co.:* in dry sandy soil along roadside, Caxambas, *1001*, distributed as *Cassia tora* L. *Jackson Co.:* along roadside, Marianna, *8342*.

Guilandina crista (L.) Small—*Dade Co.:* in dry sandy soil along roadside at edge of hammock, Buena Vista, Miami, *430;* in dry sandy soil along roadside, Buena Vista,

5481. Monroe Co.: in waste patch, Key West, *5834a.*

Herpetica alata (L.) Raf.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5491*, distributed as *Cassia alata* L.

Parkinsonia aculeata L.—*Dade Co.:* in sandy waste field, Miami, *3597. Monroe Co.:* in dry sandy soil on waste ground, Key West, *841.*

Peiranisia bahamensis (Mill.) Britton & Rose—*Dade Co.:* in dry soil at edge of Brickell Hammock, Miami, *515;* in dry sandy pineland near Hattie Bauer Hammock, Redlands district, *545a;* in waste field, Miami, *3662.* These three collections were distributed as *Cassia bahamensis* Mill.

Peltophorum ferrugineum Benth.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5728.*.

Poinciana pulcherrima L.—*Dade Co.:* in cultivation, Miami, *3596*, distributed as *Caesalpinia pulcherrima* (L.) Sw.

Psilorhegma planisiliqua (L.) Britton & Rose—*Dade Co:* in cultivation, Coconut Grove, *5695*, det. by Bailey and distributed as *Cassia glauca* Lam.

Psilorhegma suffruticosa (König) Britton—*Dade Co.:* at edge of Brickell Hammock, Miami, *488*, det. Britton, distributed as *Cassia suffruticosa* Koen.

Tamarindus indica L.—*Dade Co.:* escaped in Brickell Hammock, Miami, *5595.*

Ticanto nuga (L.) Medic.—*Dade Co.:* in cultivation, Little River, *5731*, distributed as *Caesalpinia nuga* Ait.

MIMOSACEAE

Acuan depressa (H.B.K.) Kuntze—*Monroe Co.:* in dry sandy soil along roadside, Lower Matecumbe Key, *783.*

Adenanthera pavonina L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5716.*

Albizzia lebbek Benth.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5507.*

Cailliea glomerata (Forsk.) F. Macbr.—*Dade Co.:* in dry sandy pineland, Miami, *304.*

Leptoglottis microphylla (Dryand.) Britton—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *275. Orange Co.:* in sandy field, about 3 miles west of Bithlo, *199.* Both these collections were distributed as *Morongia angustata* (T. & G.) Britton.

Leucaena glauca (L.) Benth.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5558. Lee Co.:* in dry sandy field, East Fort Myers, *990. Monroe Co.:* in dry sandy soil at edge of hammock, Key Largo, *769.*

Lysiloma bahamensis Benth.—*Dade Co.:* in Cox Hammock, west of Goulds, *643;* in waste ground, Miami, *3657.*

Mimosa strigillosa T. & G.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *843. Lee Co.:* in dry sandy ditch, west of Buckingham, *1009.*

Neptunia floridana Small—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *713;* in dry sandy soil along roadside, Buena Vista, Miami, *755a;* in dry sandy waste field, Miami, *3667.*

Pithecolobium dulce Benth.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *839a;* in cultivation, Miami, *3594;* in cultivation along roadside, Buena Vista, Miami, *5582. Lee Co.:* in sandy field, escaped from cultivation, Fort Myers, *294, 947a.*

Pithecolobium guadelupense Chapm.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *307;* in marshy soil, Silver Bluff, *729.*

Vachellia farnesiana (L.) Wight & Arn.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *276.*

FABACEAE

Abrus precatorius L.—*Dade Co.:* climbing over shrubs in Brickell Hammock, Miami, *1790;* climbing over shrubs in old avocado orchard, Buena Vista, Miami, *5503.*

Amorpha caroliniana Croom—*Dade Co.:* in dry sandy field near Brickell Hammock, Miami, *514a*, det. Rydberg. *Franklin Co.:* in dry sandy woodland, East Point, *5969.*

Amorpha crenulata Rydb.—*Dade Co.:* in dry sandy soil, Rockdale, *561*, det. Rydberg.

Amorpha croceolanata S. Wats.—*Lee Co.:* in dry sandy pineland, north of Estero, *959*, det. tentatively by Rydberg.

Amorpha dewinkeleri Small—*Lee Co.:* in dry sandy woods near Bonita Springs, Bonita Beach, *978a*, det. Rydberg. A rare species.

Amorpha fruticosa L.—*Dade Co.:* in field along roadside, Miami, *3600*.

Amorpha herbacea Walt.—*Hernando Co.:* in dry open woodland, Brooksville, *5920*.

Baptisia lanceolata Ell.—*Franklin Co.:* in dry sandy pineland, McIntyre, *1130*.

Baptisia lecontei T. & G.—*Pasco Co.:* in dry sandy field, Elfers, *1061*. *Pinellas Co.:* in dry sandy field, north of Palm Harbor, *1059a*.

Baptisia psammophila Larisey—*Madison Co.:* in dry sandy field, Greenville, *1107*, det. Larisey, distributed and cited in my Annotated List as *B. leucantha* T. & G.

Bradburya virginiana (L.) Kuntze—*Columbia Co.:* in dry sandy woods, north of High Springs, *1098;* in dry open woods, south of Ellisville, *1103a*. *Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *271*, *5455*. *Orange Co.:* in dry sandy field, about 3 miles west of Bithlo, *5381*, distributed as *Cracca rugelii* (Shuttlw.) Small.

Cajanus flavus P. DC.—*Dade Co.:* escaped from cultivation in dry sandy soil, Buena Vista, Miami, *266a*, distributed as *C. cajan* Millsp.; in cultivation, Coconut Grove, *5691*. *Monroe Co.:* in dry sandy soil along roadside, Lower Matecumbe Key, *626*, distributed as *C. cajan* Millsp.

Canavalia gladiata P. DC.—*Dade Co.:* climbing over old avocado tree, Buena Vista, Miami, *299*.

Canavalia lineata (Thunb.) P. DC.—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *376;* in cultivation, Miami, *3598*, distributed as *C. obtusifolia* DC.

Canavalia maritima (Aubl.) Thou.—*Dade Co.:* in sandy pineland, Buena Vista, Miami, *5528*.

Clitoria ternatea L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5451*.

Clitoria ternatea var. *alba* Hort.—*Monroe Co.:* climbing over weeds in dry sandy field, Key West, *805*.

Cracca ambigua (M. A. Curtis) Kuntze—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5800*. *Lee Co.:* in dry sandy soil, west of Fort Myers, *925a*, det. Rydberg.

Cracca angustissima (Shuttlw.) Kuntze—*Dade Co.:* in sandy waste field, Miami, *3587*.

Cracca chrysophylla (Pursh) Kuntze—*Orange Co.:* procumbent in dry sandy soil of roadside, south of Wekiva Springs, *5359*.

Cracca hispidula (Michx.) Kuntze—*Harder Co.:* in dry sandy pineland about 1 mile south of Bowling Green, *5913*, collected by E. T. Wherry. *Jackson Co.:* in dry soil along roadside, east of Marianna, *5977*.

Cracca intermedia Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *776a*, det. Rydberg.

Cracca rugelii (Shuttlw.) Small—*Lee Co.:* in dry sandy pineland, Fort Myers, *958*, det. Rydberg.

Cracca spicata (Walt.) Kuntze—*Broward Co.:* in dry sandy pineland, west of Davie, *455*, det. Rydberg; in dry sandy soil among palmettos, west of Pompano, *457a*, det. Rydberg. *Marion Co.:* in dry sandy woods, Irvine, *1089a*, det. Rydberg.

Crotalaria incana L.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *705;* in dry sandy soil along roadside, Buena Vista, Miami, *719a;* in cultivation, Miami, *3665;* in dry soil along roadside, Buena Vista, Miami, *5506*. *Lake Co.:* in sandy woods, west of Mt. Dora, *5361*.

Crotalaria linaria Small—*Monroe Co.:* in dry sandy pineland, Big Pine Key, *818*.

Crotalaria mucronata Desr.—*Brevard Co.:* in dry sandy soil along roadside, Mer-

ritt's Island, *216. Dade Co.:* in dry sandy field, Buena Vista, Miami, *431. Lake Co:* in sandy woods, west of Mt. Dora, *8247. Lee Co.:* in dry sandy soil, Bokeelia, *933.* These four collections were all originally distributed as *C. striata* DC.

Crotalaria pumila Ortega—Broward Co.: in dry sandy soil, Lauderdale Beach, *260. Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *378;* in sand on dunes, Golden Beach, *586a;* in dry sandy soil along roadside, Miami, *3785;* in dry sandy pineland, Buena Vista, Miami, *5494;* in dry sandy waste soil, Buena Vista, Miami, *5529.*

Crotalaria purshii P. DC.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *331a, 484b. Duval Co.:* in dry sandy field about 4 miles east of Eastport, *5262.*

Crotalaria retusa L.—*Dade Co.:* in dry sandy field, Buena Vista, Miami, *306a;* in dry sandy soil along roadside, Black Point, *400;* in cultivation, Miami, *3593;* in cultivation, Buena Vista, Miami, *5510.*

Crotalaria retzii A. S. Hitchc.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5855.*

Crotalaria rotundifolia (Walt.) Poir.—*Brevard Co.:* in dry sandy soil along roadside, about 8 miles west of Melbourne, *232. Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *319a, 324. Duval Co.:* in dry sandy waste soil, South Jacksonville, *167a. Lee Co.:* in dry sandy pineland, west of Fort Myers, *925b. Okeechobee Co.:* in dry sandy pineland, Okeechobee City, *5427.*

Crotalaria sagittalis L.—*Dade Co.:* in dry waste soil along roadside, west of Fulford, *5659.*

Crotalaria striata P. DC.—*Dade Co.:* in dry grassy field, Rockdale, *562. Jackson Co.:* along roadside, Marianna, *8350.*

Dalbergia sissoo Roxb.—*Dade Co.:* escaped at edge of hammock, Miami, *5597.*

Daubentonia longifolia (Cav.) P. DC.—*Manatee Co.:* in moist sandy soil along roadside, south of Cates City, *1044.*

Dolicholus minimus (L.) Medic.—*Dade Co.:* in dry sandy soil, Brickell Hammock, *490;* climbing over weeds, Miami, *512a;* in waste soil along roadside, Miami, *3788.*

Dolichos lablab L.—*Monroe Co.:* climbing over low shrubs in dry sandy soil, Lower Matecumbe Key, *624;* climbing over weeds in waste ground, Key West, *804.*

Ecastophyllum brownei Pers.—*Dade Co.:* at edge of hammock, old Cutler road, *5806,* distributed as *Dalbergia brownei* (Pers.) Kuntze. *Lee Co.:* on dry sandy shore, Fort Myers, *1384,* collected by W. M. Buswell; along beach, Bokeelia, *5881.* The last two of these collections were distributed as *Dalbergia ecastophyllum* (L.) Taub.

Erythrina arborea (Chapm.) Small—*Dade Co.:* in hammock, Alta Vista, Miami, *370.*

Galactia elliottii Nutt.—*Lee Co.:* in dry sandy soil, Big Pine Island, *734;* in dry sandy soil along roadside, west of Fort Myers, *925.*

Galactia pinetorum Small—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *268;* climbing over weeds in dry sandy soil, Buena Vista, Miami, *580a;* in sandy pineland, Miami, *3599.*

Galactia regularis (L.) B.S.P.—*Lee Co.:* in dry sandy pine woods, Fort Myers, *647, 951.*

Galactia spiciformis T. & G.—*Dade Co.:* twining over weeds along roadside, Homestead, *5822. Monroe Co.:* climbing over low shrubs, Cypress Lodge, Pine Crest, *348;* climbing over tall weeds along roadside, Boca Chica Key, *810.*

Gliricidia maculata Steud.—*Dade Co.:* in cultivation, Coconut Grove, *5808.*

Ichthyomethia piscipula (L.) A. S. Hitchc.—*Lee Co.:* on kitchen-midden, Coconut, *5779.*

Indigofera keyensis Small—*Monroe Co.:* in dry sandy soil, Lower Matecumbe Key, *625.*

Indigofera miniata Ortega—*Dade Co.:* in lawns and waste ground, Miami, *3602.*

Indigofera suffruticosa Mill.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami,

366a; in dry sandy pineland, Buena Vista, Miami, *5478. Hernando Co.:* in sandy waste soil, Brooksville, *5938.*

Indigofera tinctoria L.—*Monroe Co.:* in waste ground, Key West, *5840a.*

Kraunhia frutescens (L.) Greene—*Franklin Co.:* in dry sandy woods, Carrabelle, *1119a.*

Kuhnistera pinnata (Walt.) Kuntze—*Dade Co.:* at edge of Tamiami Trail, 25 miles west of Miami, *3767. Orange Co.:* in dry sandy woods, south of Wekiva Springs, *192.*

Lupinus diffusus Nutt.—*Broward Co.:* in dry sandy pineland, Pompano, *264. Hendry Co.:* in dry sandy soil, Labelle, *1016. Lee Co.:* in dry sandy pineland, Fort Myers, *5790.*

Lupinus villosus Willd.—*Suwannee Co.:* in dry sandy soil, Houseton, *1104.*

Medicago hispida Gaertn.—*Leon Co.:* in dry sandy soil, Tallahassee, *1111.*

Meibomia cana (J. F. Gmel.) Blake—*Jackson Co.:* along edge of field, Marianna, *8346.*

Meibomia canescens (L.) Kuntze—*Dade Co.:* at edge of hammock, Arch Creek, *5878.*

Meibomia laevigata (Nutt.) Kuntze—*Volusia Co.:* in dry sandy soil along roadside, Mosquito Inlet, *5312.*

Meibomia paniculata (L.) Kuntze—*Hernando Co.:* in dry sandy woods, Brooksville, *5947.*

Meibomia purpurea (Mill.) Vail—*Broward Co.:* in dry sandy soil along roadside, about 4 miles west of Davie, *5613. Dade Co.:* in dry sandy soil along roadside, Buena Vista, Miami, *285;* at edge of hammock, near Brickell Hammock, Miami, *521a;* in sandy soil at edge of hammock, Miami, *3601;* in sandy soil along roadside, Buena Vista, Miami, *5471.*

Meibomia rhombifolia (Ell.) Vail—*Broward Co.:* in dry sandy soil, west of Pompano, *478a.*

Meibomia supina (Sw.) Britton—*Brevard Co.:* in moist ditch about 2 miles west of Melbourne, *221. Dade Co.:* in dry sandy soil along roadside, Redlands, *564a;* in dry sandy pineland, Buena Vista, Miami, *714. Lee Co.:* in moist soil along ditch, Coconut, *967.*

Meibomia triflora (L.) Kuntze—*Hendry Co.:* in dry sandy soil along roadside, Labelle, *1017.*

Meibomia viridiflora (L.) Kuntze—*Hernando Co.:* in dry open woods, Brooksville, *1055.*

Melilotus indica (L.) All.—*Gulf Co.:* in dry sandy soil, Apalachicola, *1140a. Manatee Co.:* in moist ditch along roadside, Ellenton, *1045.*

Mucuna deeringiana (Bart.) Small—*Dade Co.:* in dry waste pineland, Buena Vista, Miami, *5454.*

Mucuna urens (L.) P. DC.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5509.*

Parosela domingensis (P. DC.) Heller—*Dade Co.:* along roadside, Miami, *3786.*

Parosela floridana Rydb.—*Dade Co.:* at edge of Cox Hammock, west of Goulds, *646. Monroe Co.:* in dry soil on canal bank, Cypress Lodge, Pine Crest, *346.*

Petalostemon carneus Michx.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *295;* in dry sandy soil among palmettos, Buena Vista, *310;* in sandy pineland, Miami, *3668.*

Petalostemon feayi Chapm.—*Orange Co.:* in dry sandy woods, south of Wekiva Springs, *5360.*

Pongamia pinnata (L.) Merr.—*Dade Co.:* at edge of Brickell Hammock, Miami, *5702.*

Psoralea gracilis Chapm.—*Baker Co.:* in dry sandy field, Glen St. Mary, *1178;* in dry sandy field, east of Glen St. Mary, *1178a.*

Rhynchosia cinerea Nash—*Dade Co.:* in dry sandy pineland, Seminole Plains,

Black Point, *423;* in dry sandy pineland, Miami, *491a.* Both these collections were distributed as *Dolicholus cinereus* (Nash) Vail.

Rhynchosia intermedia (T. & G.) Small—*Marion Co.:* in dry open woods, east of Flemington, *1085a,* distributed as *Dolicholus intermedius* (T. & G.) Vail.

Rhynchosia michauxii Vail—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *315,* distributed as *Dolicholus simplicifolius* (Walt.) Vail.

Rhynchosia mollissima (Ell.) S. Wats.—*Hernando Co.:* in open woods, Brooksville, *1079,* distributed as *Dolicholus mollissimus* (Ell.) Vail.

Rhynchosia simplicifolia (Walt.) Wood—*Dade Co.:* trailing in pineland, Miami, *3787,* distributed as *Dolicholus simplicifolius* (Walt.) Vail.

Sophora tomentosa L.—*Dade Co.:* in dry sandy soil along beach, Miami Beach, *544. Lee Co.:* in dry sandy soil, Bokeelia, *936a.*

Stylosanthes biflora (L.) B.S.P.—*Dade Co.:* in cut lawn and waste ground, Miami, *3575.*

Stylosanthes hamata (L.) Taub.—*Dade Co.:* in dry sandy soil, Miami, *778.*

Vicia acutifolia Ell.—*Collier Co.:* in dry sandy soil along roadside, about 20 miles north of Big Bend, on the Tamiami Trail, *5616. Dade Co.:* in moist sandy ditch, Little River, *439.*

Vicia sativa L.—*Leon Co.:* climbing over weeds in dry sandy soil, Tallahassee, *1113.*

Vigna repens (L.) Kuntze—*Dade Co.:* in dry sandy soil near Bay Biscayne, Buena Vista, Miami, *300;* climbing over low weeds in sandy soil along roadside, Coconut Grove, *730;* in waste sandy soil, Miami, *3694;* twining over tall weeds, Buena Vista, Miami, *5531. Volusia Co.:* vine twining over tall weeds, near Oak Hill, *5320.*

SALICACEAE

Salix amphibia Small—*Monroe Co.:* in moist soil along edge of canal, Cypress Lodge, Pine Crest, *342.*

MYRICACEAE

Cerothamnus ceriferus (L.) Small—*Broward Co.:* in dry sandy soil, Long Island, west of Davie, *502. Volusia Co.:* in dry sandy soil, Mosquito Inlet, *5310.*

Cerothamnus pumilus (Michx.) Small—*Broward Co.:* in dry sandy pineland, west of Pompano, *5579. Lee Co.:* in dry sandy soil along palmettos, north of Estero, *962.*

FAGACEAE

Castanea nana Muhl.—*Columbia Co.:* in dry sandy woods, north of High Springs, *1099.*

Quercus chapmanii Sarg.—*Collier Co.:* at edge of hammock, Tamiami Trail, *5763. Dade Co.:* in dry sandy soil along roadside, Buena Vista, Miami, *602;* in dry sandy pineland, Buena Vista, Miami, *5809, 5810. Lee Co.:* in dry sandy pineland, east of Owanita, *5909. Orange Co.:* in sandy woods, about 3 miles north of Winter Park, *5340.*

Quercus geminata Small—*Lee Co.:* in dry sandy soil among *Ceratiola* association, near Bonita Beach, *979;* in dry sandy soil, east of Owanita, *1013.*

Quercus laevis Walt.—*Collier Co.:* along old Tamiami Trail, *5898. Columbia Co.:* in dry sandy woods, north of High Springs, *5955. Duval Co.:* in oak woods about 4 miles east of Eastport, *5264. St. Johns Co.:* in sandy woods near Moultrie, *5294.*

Quercus laurifolia Michx.—*Hendry Co.:* in sandy pineland, Labelle, *5912. Leon Co.:* at edge of woods, Tallahassee, *5981.*

Quercus margaretta Ashe.—*Columbia Co.:* in dry sandy woods, north of High Springs, *5954. Hernando Co.:* in sandy woods, southwest of Brooksville, *5934. St. Johns Co.:* in sandy woods near Moultrie, *5295.*

Quercus marilandica Muenchh.—*Marion Co.:* in dry sandy woodland, east of Flemington, *5951.*

Quercus minima (Sarg.) Small—*Dade Co:* in dry sandy soil among palmettos, Buena Vista, Miami, *717;* in dry sandy pineland, Miami, *777;* in sandy soil, Miami,

3666; in sandy pineland, Buena Vista, Miami, *5461, 5667. Lee Co.:* in dry sandy soil, west of Buckingham, *1012. Orange Co.:* in dry sandy soil along roadside, Orlando, *5337.*

Quercus myrtifolia Willd.—*Dade Co.:* in dry sandy soil along roadside, Buena Vista, Miami, *754, 5668;* in dry sandy soil among palmettos, Buena Vista, Miami, *754a;* in sandy pineland, Buena Vista, Miami, *5462. Orange Co.:* in dry sandy soil along roadside, Orlando, *5335.*

Quercus nigra L.—*Duval Co.:* at edge of woods, about 4 miles east of Eastport, *5279. Leon Co.:* in dry woodland, Tallahassee, *5962;* in moist woodland, Tallahassee, *5980.*

Quercus pumila Walt.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *604;* in dry sandy pineland, Buena Vista, Miami, *755, 5665;* in dry sandy soil among palmettos, Buena Vista, Miami, *756;* in dry sandy pineland, South Miami, *776b;* in sandy pineland, Miami, *3663.*

Quercus stellata Wang.—*Orange Co.:* in dry sandy woods, south of Wekiva Springs, *5353;* along roadside, south of Wekiva Springs, *5355.*

Quercus subfalcata Trelease—*Hernando Co.:* in thicket along roadside, Brooksville, *5945,* distributed as *Q. falcata* x *phellos.*

Quercus virginiana Mill.—*Dade Co.:* in dry sandy soil, Miami, *335;* in waste sandy soil, Miami, *3664;* in dry sandy pineland, Buena Vista, Miami, *5465, 5512, 5664, 5666, 5854;* along roadside, Buena Vista, Miami, *5466. Lake Co.:* in dry sandy woods, near Tavares, *5362. Lee Co.:* along roadside, Fort Myers, *5792a. Monroe Co.:* in hammock, Key Largo, *5586,* collected by C. A. Mosier. *Orange Co.:* in dry sandy woods, south of Wekiva Springs, *5352, 5354. St. Johns Co.:* along roadside, St. Augustine, *5250. Volusia Co.:* at edge of woods, near Ariel, *5315.*

Quercus sp.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *718a;* in dry sandy pineland, Buena Vista, Miami, *5464. Pasco Co.:* at edge of thicket, New Port Richey, *5931.*

CASUARINACEAE

Casuarina cunninghamiana Miq.—*Dade Co.:* in dry sandy soil along roadside, apparently escaped from cultivation, west of Goulds, *638.*

Casuarina equisetifolia L.—*Dade Co.:* in cultivation, Miami, *3708;* in cultivation, Buena Vista, Miami, *5797. Monroe Co.:* in dry sandy soil at edge of canal, Key Largo, *768.*

ULMACEAE

Celtis mississippiensis Bosc—*Dade Co.:* in hammock, west of Fulford, *5573.*

Trema floridana Britton—*Dade Co.:* in dry sandy soil, Miami, *779;* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3715;* along roadside, Silver Bluff, *5805;* at edge of thicket, Cutler district, *5807.*

Trema lamarckiana (R. & S.) Blume—*Monroe Co.:* in sandy soil at edge of hammock, north end of Key Largo, *773.*

MORACEAE

Artocarpus lakoocha Roxb.—*Dade Co.:* in cultivation, Coconut Grove, *5675.*

Cecropia palmata Willd.—*Dade Co:* in cultivation, Buena Vista, Miami, *5713.*

Ficus altissima Blume—*Dade Co.:* in cultivation along roadside, Brickell Hammock, Miami, *5594.*

Ficus aurea Nutt.—*Dade Co.:* in hammock, along Tamiami Trail, 25 miles west of Miami, *3712;* at edge of Brickell Hammock, Miami, *5623.*

Ficus benghalensis L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5717.*

Ficus benjamina L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5638. Lee Co.:* in cultivation on Edison estate, Fort Myers, *6488,* collected by W. M. Buswell.

Ficus brevifolia Nutt.—*Dade Co.:* in hammock along Tamiami Trail, 25 miles west of Miami, *3714;* in Brickell Hammock, Miami, *5622.*

Ficus cunninghamii Miq.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5720.*

Ficus glomerata Roxb.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5727.*

Ficus hispida L.—*Dade Co.:* in cultivation, Coconut Grove, *5684.*

Ficus infectoria Roxb.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5709. Orange Co.:* in cultivation near old Court House, Orlando, *5374.*

Ficus nitida Thunb.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5707.*

Ficus nymphaefolia Mill.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5852.*

Ficus padifolia H.B.K.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5851.*

Ficus pandurata Sander—*Dade Co.:* in cultivation, Miami, *3709.*

Ficus religiosa L.—*Dade Co.:* in cultivation along roadside, Brickell Hammock, Miami, *5634. Lee Co.:* in cultivation, Boca Grande, *6485, 6486.*

Ficus roxburghii Wall.—*Dade Co.:* in cultivation, Coconut Grove, *5678.*

Ficus rubiginosa Desf.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5721.*

Ficus sycomorus L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5554.*

Ficus sp.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5473, 6538,* det. Bailey.

Morus rubra L.—*Dade Co.:* at edge of hammock, Brickell Hammock, Miami, *5856a;* in Brickell Hammock, Miami, *5862.*

URTICACEAE

Boehmeria cylindrica (L.) Sw.—*Dade Co.:* in dry soil on canal embankment, east of Big Bend, along Tamiami Trail, *339.*

Parietaria floridana Nutt.—*Dade Co.:* in rich soil of cultivated land, Little River, *609.*

Pilea microphylla (L.) Liebm.—*Dade Co.:* in dry sandy soil along roadside, Snapper Creek, *733;* in cultivation, Miami, *3687.*

ILICACEAE

Ilex buswellii Small—*Lee Co.:* in dry sandy thicket, Fort Myers, type locality, *802, 991, 5789.* This is a very rare species.

Ilex cassine L.—*Dade Co.:* in sandy soil along edge of canal, along Tamiami Trail, *896;* in waste ground, Miami, *3624;* at edge of canal, Tamiami Trail, east of Big Bend, *5515. Lee Co.:* in hammock, Bonita Beach, *978.*

Ilex glabra (L.) A. Gray—*Baker Co.:* in dry sandy woods, Glen St. Mary, *1177a. Dade Co.:* in dry sandy pineland, Opa-Locka, *451. Glades Co.:* in pineland, near Citrus Center, *8400. Madison Co.:* in dry sandy woods, west of Greenville, *1108. Sarasota Co.:* in dry sandy soil along roadside, about 8 miles southeast of Venice, *1036.*

Ilex krugiana Loes.—*Dade Co.:* in hammock, Hattie Bauer Hammock, *5644.*

Ilex vomitoria Ait.—*Glades Co.:* in sandy pineland, near Citrus Center, *8398.*

EMPETRACEAE

Ceratiola ericoides Michx.—*Dade Co.:* in dry sandy scrub, Miami, *5875. Lake Co.:* in sandy open woods, north of Mineola, *5371.*

CELASTRACEAE

Catha edulis Forsk.—*Dade Co.:* escaped from cultivation, Brickell Hammock, Miami, *5626.*

Elaeodendron xylocarpum (Vent.) P. DC.—*Dade Co.:* in cultivation at Chapman Field, Coconut Grove, *10708,* collected by Mrs. J. R. Swanson.

Elaeodendron xylocarpum var. *caribaeum* Urb.—*Dade Co.:* just beyond the marsh along the bay where the pineland begins, Coconut Grove, *10698,* collected by Mrs. J. R. Swanson [this collection was erroneously cited as from Bermuda in my Annotated List].

Rhacoma ilicifolia (Poir.) Trelease—*Dade Co.:* in dry sandy pineland, Redlands, *548;* in dry sandy pineland, Buena Vista, Miami, *5501.*

HIPPOCRATEACEAE

Hippocratea volubilis L.—*Dade Co.:* sprawling over sand at edge of bay, near Brickell Hammock, Miami, *801;* in hammock along roadside, Miami, *3603.*

OLACACEAE

Schoepfia chrysophylloides (A. Rich.) Planch.—*Dade Co.:* in waste ground, Miami, *3604*, distributed as *S. schreberi* Gmel. and so cited in my Annotated List; at edge of hammock, Arch Creek, *5877*.

Ximenia americana L.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *374;* at edge of Bay Biscayne, Buena Vista, Miami, *5505*.

RHAMNACEAE

Berchemia scandens (Hill) Trelease—*Collier Co.:* at edge of trail by hammock, Tamiami Trail, *5759*. *Monroe Co.:* climbing over low shrubs, Pine Crest, *855;* climbing over shrubs at edge of hammock, Pine Crest, *881*.

Ceanothus intermedius Pursh—*Orange Co.:* in dry sandy oak woods, south of Wekiva Springs, *188*.

Ceanothus microphyllus Michx.—*Orange Co.:* in dry sandy oak woods, south of Wekiva Springs, *189*.

Colubrina asiatica (L.) Brongn.—*Dade Co.:* in dry sandy soil along edge of canal near Bay Biscayne, Buena Vista, Miami, *573*.

Colubrina cubensis (Jacq.) Brongn.—*Dade Co.:* in Lewis-Nixon Hammock, Redlands district, *553*.

Colubrina ferruginosa Brongn.—*Dade Co.:* in Lewis-Nixon Hammock, Redlands district, *552*.

Sageretia minutiflora (Michx.) Trelease—*Hernando Co.:* at edge of woods, south of Aripeka, *5933*.

Zizyphus jujuba Mill.—*Dade Co.:* in cultivation, Coconut Grove, *5671*.

VITACEAE

Ampelopsis arborea (L.) Rusby—*Collier Co.:* at edge of hammock, south of Tamiami Trail, *5869*.

Cissus sicyoides L.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3766*. *Martin Co.:* climbing over low bushes, about 1 mile north of Fort Mayaca, *247*.

Muscadinia munsoniana (Simpson) Small—*Broward Co.:* in hammock, Long Island, west of Davie, *5602*. *Lee Co.:* in dry soil along fence, East Fort Myers, *988*. *Monroe Co.:* in sandy soil along fence, Key Largo, *770;* at edge of hammock, north end of Key Largo, *773a*.

Muscadinia rotundifolia (Michx.) Small—*Dade Co.:* in hammock along edge of road, Miami, *3606*. *Volusia Co.:* in sandy soil along roadside, Mosquito Inlet, *5307*.

Tetrastigma harmandi Planch.—*Dade Co.:* escaped from cultivation in waste ground, Brickell Hammock, Miami, *5629*.

Vitis cinerea Engelm.—*Collier Co.:* climbing over low shrubs at edge of wet hammock, south of Tamiami Trail, *877;* in clearing, Turner's River Hammock, *5765*.

Vitis coriacea Shuttlw.—*Dade Co.:* in hammock, Comfort Canal region, Miami, *5641*.

Vitis simpsonii Munson—*Collier Co.:* climbing over shrubs in dry sandy soil, Caxambas, *1005*.

RUTACEAE

Casimiroa edulis Llave & Lex.—*Dade Co.:* in cultivation, Coconut Grove, *5688*.

Clausena lansium Skeels—*Dade Co.:* in cultivation, Coconut Grove, *5682*.

Zanthoxylum clava-herculis L.—*Dade Co.:* in waste sandy soil, Buena Vista, Miami, *5871*.

Zanthoxylum fagara (L.) Sarg.—*Dade Co.:* in Brickell Hammock, Miami, *5633*. *Lee Co.:* in dry sandy hammock, Bokeelia *678*, *937*.

AURANTIACEAE

Citrus aurantifolia (Christm.) Swingle—*Dade Co.:* in cultivation, Miami, *3605;* in cultivation, Buena Vista, Miami, *5549*.

Citrus medica L.—*Dade Co.:* in cultivation, Miami, *3670.*

Citrus paradisi Macfadyen—*Dade Co.:* in cultivation, Buena Vista, Miami, *5548,* distributed as *C. maxima* Merr.

Citrus sinensis Osbeck—*Dade Co.:* in cultivation, Buena Vista, Miami, *5547.*

Citrus taitensis Risso—*Dade Co.:* in cultivation, Buena Vista, Miami, *5802.*

Citrus vulgaris Risso—*Broward Co.:* in hammock, Long Island, west of Davie, *5605.*

Triphasia trifolia P. Wils.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5556, 5718.*

SURIANACEAE

Suriana maritima L.—*Broward Co.:* in sand on coastal sand-dunes, north of Hollywood, *595.*

SIMAROUBACEAE

Picramnia pentandra Sw.—*Dade Co.:* at edge of Brickell Hammock, Miami, *5703.*

Simarouba glauca var. *latifolia* Cronquist—*Dade Co.:* in cultivation, Miami, *3669,* det. Cronquist. *Monroe Co.:* in hammock, Key Largo, *823,* det. Cronquist.

BURSERACEAE

Elaphrium simaruba (L.) Rose—*Broward Co.:* Long Island, west of Davie, *5601. Collier Co.:* in dry sandy soil of hammock, Caxambas, *1004.*

MELIACEAE

Melia azedarach L.—*Dade Co.:* in cultivation, Coconut Grove, *5683.*

Swietenia mahagonia Jacq.—*Monroe Co.:* in hammock, Key Largo, *5537.*

SAPINDACEAE

Blighia sapida König—*Dade Co.:* in cultivation, Buena Vista, Miami, *5553.*

Cardiospermum halicacabum L.—*Dade Co.:* climbing over shrubs, Buena Vista, Miami, *301.*

Cardiospermum microcarpum H.B.K.—*Collier Co.:* in rich moist soil, Turner's River Hammock, *668.*

Euphoria longana Lam.—*Lee Co.:* in cultivation, Fort Myers, *5887.*

Exothea paniculata (A. L. Juss.) Radlk.—*Dade Co.:* in Hattie Bauer Hammock, Redlands district, *5645.*

Hypelate trifoliata Sw.—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5742.*

Sapindus saponaria L.—*Dade Co.:* in hammock, Miami, *3672.*

ACERACEAE

Rufacer carolinianum (Walt.) Small—*Leon Co.:* in cultivation along street, Tallahassee, *5963. Monroe Co.:* in hammock, Key Largo, *5587,* collected by C. A. Mosier. *Sarasota Co.:* at edge of woods, north of Venice, *5919.* These three collections were originally distributed as *Acer carolinianum* Walt.

DODONAEACEAE

Dodonaea jamaicensis P. DC.—*Dade Co.:* in grassy field near Brickell Hammock, Miami, *514.*

Dodonaea viscosa L.—*Dade Co.:* in hammock, Miami, *3576.*

ANACARDIACEAE

Mangifera indica L.—*Dade Co.:* in cultivation, Miami, *3610. Monroe Co.:* in dry sandy waste soil, Key West, *840.*

Metopium toxiferum (L.) Krug & Urb.—*Dade Co.:* in dry soil at edge of woods, Homestead, *778a;* in hammock, Buena Vista, Miami, *5495.*

Rhus copallinum var. *leucantha* P. DC.—*Dade Co.:* in sandy woods, Miami, *3674. Monroe Co.:* in dry sandy soil along roadside, near Pine Crest, *367.* Both these collections were originally distributed as *R. obtusifolia* Small.

Rhus obtusifolia Small—*Hendry Co.:* in dry sandy soil along roadside, Labelle, *1031a.*

Schinus dependens Ortega—*Dade Co.:* in cultivation, Coconut Grove, *5674.*

Schinus terebinthifolius Raddi—*Dade Co.:* in cultivation, Miami, *3673;* in cultivation, Buena Vista, Miami, *5559.*

Toxicodendron radicans (L.) Kuntze—*Martin Co.:* in sandy soil along roadside, about 1 mile north of Fort Mayaca, *5440.*

JUGLANDACEAE

Carya cordiformis (Wangh.) K. Koch—*Franklin Co.:* in sandy woodland, East Point, *5971.*

CORNACEAE

Svida stricta (Lam.) Small—*Collier Co.:* in wet hammock, south of Tamiami Trail, *876.*

NYSSACEAE

Nyssa ursina Small—*Gulf Co.:* in moist sandy soil, south of Dalkeith, *1153.*

ARALIACEAE

Hedera helix L.—*Glades Co.:* escaped from cultivation along fence, near Citrus Center, *8399.*

Polyscias fruticosa Harms—*Dade Co.:* in cultivation, Miami, *3609.*

Polyscias guilfoylei L. H. Bailey—*Dade Co.:* in cultivation, Miami, *3608.*

Polyscias guilfoylei var. *laciniata* L. H. Bailey—*Dade Co.:* in cultivation, Miami, *3607.*

AMMIACEAE

Centella repanda (Pers.) Small—*Broward Co.:* in moist sandy soil, Hollywood, *592.*

Cicuta curtissii Coult. & Rose—*Glades Co.:* in boggy ditch, Moore Haven, *1026.*

Cyclospermum ammi (L.) Britton—*Leon Co.:* in moist ditch, Tallahassee, *5982.*

Daucus pusillus Michx.—*Wakulla Co.:* in dry sandy soil along roadside, Wakulla, *1121.*

Eryngium aromaticum Baldw.—*St. Johns Co.:* in dry sandy woods, near Moultrie, *176a.*

Eryngium baldwinii Spreng.—*Lee Co.:* in sandy ditch on road to Coconut, south of Estero, *971;* in dry sandy pineland, west of Fort Myers, *5880.*

Eryngium synchaetum (A. Gray) Rose—*Pinellas Co.:* in moist sandy field, St. Petersburg, *1075a.*

Foeniculum vulgare Mill.—*Monroe Co.:* in dry sandy waste ground, Key West, *797a.*

Hydrocotyle bonariensis Lam.—*Duval Co.:* in dry sand along roadside near coast, about 4 miles east of Eastport, *173a,* originally distributed as *H. umbellata* L. *Gulf Co.:* in deep sand on coast at edge of Gulf of Mexico, Apalachicola, *1141, 1149.*

Hydrocotyle umbellata L.—*Clay Co.:* in wet sand about 2 miles north of Orange Park, *5238. Leon Co.:* in wet grassy field, Tallahassee, *1115. Volusia Co.:* in dry sandy soil along roadside, near Ariel, *5317.*

Hydrocotyle verticillata Thunb.—*Sarasota Co.:* in moist sandy ditch, north of Venice, *5918.*

Oxypolis filiformis (Walt.) Britton—*Monroe Co.:* in water of everglades, Pine Crest, *363a.*

Ptilimnium capillaceum (Michx.) Raf.—*Lee Co.:* in wet sandy ditch along roadside, south of Fort Myers, *912;* in wet ditch, Fort Myers, *5771.*

Spermolepis divaricatus (Walt.) Britton—*Pinellas Co.:* in dry sandy ditch along roadside, Seminole, *1057.*

ERICACEAE

Befaria racemosa Vent.—*Dade Co.:* among palmettos in dry sandy pineland west of Fulford, *601, 5572.*

Desmothamnus lucidus (Lam.) Small—*Dade Co.:* in dry sandy soil among palmettos, west of Fulford, *454. Gulf Co.:* in dry sandy pineland, Apalachicola, *1141a.*

Eubotrys racemosa (L.) Nutt.—*Madison Co.:* in moist woodland thicket, west of Greenville, *1110.*

Kalmiella hirsuta (Lam.) Small—*Franklin Co.:* in dry sandy pineland, Carrabelle, *884, 1134.*

Neopieris mariana (L.) Britton—*Madison Co.:* in sandy woods, west of Greenville, *1109. Wakulla Co.:* in moist soil at edge of woods, Wakulla, *1121a.*

Xolisma fruticosa (Michx.) Nash—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *326a. Highlands Co.:* in dry sandy soil, near Childs, *5418.*

VACCINIACEAE

Batodendron arboreum (Marsh.) Nutt.—*Hernando Co.:* at edge of thicket, Brooksville, *5939. Lee Co.:* in thicket along roadside, east of Owanita, *1015. Leon Co.:* in moist woods, Tallahassee, *1172. Pasco Co.:* in sandy woods, New Port Richey, *1062.*

Cyanococcus myrsinites (Lam.) Small—*Dade Co.:* in sandy pineland, Opa-Locka, *449. Lee Co.:* in dry sandy pineland, Fort Myers, *948. Okeechobee Co.:* in sandy pineland, Okeechobee City, *5429. Orange Co.:* in dry waste soil, Orlando, *5328.* The first two and last of these collections were distributed as *Vaccinium myrsinites* Michx. and the other as *V. nitidum* Andr.

Lasiococcus dumosus (Andr.) Small—*Lee Co.:* in dry sandy pineland, Fort Myers, *652, 944;* in dry sandy pineland, Big Pine Island, *5883. Volusia Co.:* in sand on dunes, Mosquito Inlet, *5308.* These four collections were originally distributed as *Gaylussacia dumosa* (Andr.) T. & G.

Lasiococcus mosieri (Small) Small—*Gulf Co.:* in dry sandy pineland, Apalachicola, *1140,* originally distributed as *Gaylussacia mosierii* Small.

Polycodium caesium Greene—*Hendry Co.:* in dry sandy soil, Labelle, *5910. Lee Co.:* in dry sandy pineland, Fort Myers, *914.*

EBENACEAE

Diospyros mosierii Small—*Broward Co.:* at edge of hammock, Long Island, west of Davie, *5606. Dade Co.:* in hammock, Opa-Locka, *887.*

Diospyros virginiana L.—*Lee Co.:* in dry grassy pasture, east of Owanita, *1014.*

SAPOTACEAE

Bumelia angustifolia Nutt.—*Lee Co.:* in sand on midden, Coconut, *5780.*

Bumelia tenax (L.) Willd.—*Collier Co.:* on dunes, Caxambas, *5903;* on hill, Caxambas, *6537. Volusia Co.:* along roadside, Mosquito Inlet, *7362.*

Chrysophyllum olivaeforme L.—*Broward Co.:* in hammock, Long Island, west of Davie, *5604.*

Dipholis salicifolia (L.) P. DC.—*Dade Co.:* in hammock south of Florida City, *750;* in Brickell Hammock, Miami, *5701.*

Lucuma nervosa A. DC.—*Dade Co.:* in cultivation, Coconut Grove, *5680.*

Mimusops emarginata (L.) Britton—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5744;* at edge of road, Lower Matecumbe Key, *5749.*

Sapota achras Mill.—*Dade Co.:* in cultivation, Coconut Grove, *5676.*

Siderocarpos flexicaulis (Benth.) Sondl.—*Dade Co.:* in cultivation along fence, Brickell Hammock, Miami, *5804.*

Sideroxylon foetidissimum Jacq.—*Lee Co.:* along roadside, Bokeelia, *5882. Monroe Co.:* in hammock, Key Largo, *5584,* collected by C. A. Mosier.

MYRSINACEAE

Icacorea paniculata (Nutt.) Sudw.—*Dade Co.:* in dry hammock, Alta Vista, Miami, *371a;* in dry sandy soil, Homestead, *401.*

Rapania guyanensis Aubl.—*Dade Co.:* in dry hammock, Alta Vista, Miami, *371.*

THEOPHRASTACEAE

Jacquinia keyensis Mez—*Monroe Co.:* in sandy hammock, Lower Matecumbe Key, *627.*

LOGANIACEAE

Cynoctonum mitreola (L.) Britton—*Brevard Co.:* in dry sandy waste soil near Melbourne, *5397. Monroe Co.:* in moist sandy soil, Cypress Lodge, Pine Crest, *349.*

Polypremum procumbens L.—*Dade Co.:* in dry sandy waste ground, Buena Vista, Miami, *5499. Duval Co.:* in dry sandy soil about 4 miles east of Eastport, *5283. Monroe Co.:* in dry sandy soil at edge of road, Pine Crest, *881a.*

OLEACEAE

Amarolea americana (L.) Small—*Franklin Co.:* in sandy woods, East Point, *5972,* originally distributed as *Symplocos tinctoria* (L.) L'Hér.

Forestiera pinetorum Small—*Dade Co.:* in dry sandy marl, Goulds, *543.*

Forestiera segregata (Jacq.) Krug & Urb.—*Dade Co.:* in dry sandy pineland, Miami, *375;* near Bay Biscayne, Buena Vista, Miami, *5480;* in hammock, Arch Creek, *5879.* The first and third of these collections were originally distributed as *F. porulosa* (Michx.) Poir.

Fraxinus caroliniana Mill.—*Collier Co.:* in about 3 feet of water at edge of wet hammock, south of Tamiami Trail, *868. Okeechobee Co.:* along edge of lake, Okeechobee City, *5431.*

Fraxinus pauciflora Nutt.—*Duval Co.:* in boggy woods, about 5 miles east of South Jacksonville, *5227.*

Jasminum azoricum L.—*Monroe Co.:* climbing over shrubs in waste lot, Key West, *804a.*

Jasminum pubescens Willd.—*Orange Co.:* in cultivation, Orlando, *5321.*

Jasminum sambac Soland.—*Dade Co.:* in cultivation, Miami, *3798.*

Ligustrum ovalifolium Hassk.—*Dade Co.:* at edge of Brickell Hammock, Miami, *5636.*

APOCYNACEAE

Allamanda cathartica var. *hendersonii* Raffel.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5446.*

Allamanda cathartica var. *williamsii* Hort.—*Dade Co.:* in cultivation, Miami, *3573.*

Amsonia ciliata Walt.—*Hernando Co.:* in dry sandy oak woods, north of Aripeka, *1066.*

Angadenia berterii (A. DC.) Miers—*Dade Co.:* in dry sandy marl, Goulds, *399a,* originally distributed as *Rhabdadenia corallicola* Small.

Carissa grandiflora A. DC.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5450.*

Catharanthus roseus (L.) G. Don—*Dade Co.:* in dry sandy soil at edge of hammock, Miami, *427,* originally distributed as *Ammocallis rosea* (L.) Small.

Echites umbellata Jacq.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5500.*

Rhabdadenia biflora (Jacq.) Muell. Arg.—*Dade Co.:* in sandy soil near edge of bay, by hammock, Brickell Hammock, Miami, *725;* at edge of mangrove swamp, Miami Beach, *5534. Lee Co.:* in sandy soil at edge of river, Fort Myers, *6483,* collected by W. M. Buswell.

Thevetia peruviana (Pers.) K. Schum.—*Dade Co.:* in cultivation, Miami, *3783,* originally distributed as *T. nereifolia* Juss.

Urechites lutea (L.) Britton—*Collier Co.:* in dry sandy soil, Caxambas, *1006a. Lee Co.:* on midden, Coconut, *5784.*

ASCLEPIADACEAE

Amphistelma scoparia (Nutt.) Small—*Monroe Co.:* climbing over shrubs, Cypress Lodge, Pine Crest, *355.*

Asclepias curassavica L.—*Dade Co.:* in dry sandy waste ground, Buena Vista, Miami, *284.*

Asclepias humistrata Walt.—*Dade Co.:* in dry sandy soil along roadside, Buena Vista, Miami, *374a. Pasco Co.:* in dry sandy soil along roadside, Elfers, *1060.*

Asclepias lanceolata Walt.—*Collier Co.:* in everglades along Tamiami Trail, *702. Dade Co.:* at edge of Lewis-Nixon Hammock, Redlands district, *5648.*

Asclepias michauxii Decaisne—*Calhoun Co.:* in moist sandy pineland, Myron, *1160. Columbia Co.:* in moist grassy field south of Ellisville, *5956. Gulf Co.:* in moist sandy field, Dalkeith, *1155a.*

Asclepias rolfsii Britton—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *274;* in dry sandy marl, Goulds, *379a. Lee Co.:* in dry sandy pine woods, Fort Myers, *952.*

Asclepias tomentosa Ell.—*Collier Co.:* in dry sandy soil, Caxambas, *5904.*

Asclepias verticillata L.—*Collier Co.:* growing in water of everglades along Tamiami Trail, *701a. Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *700a. Hernando Co.:* in dry sandy ditch along roadside, southwest of Brooksville, *5936.*

Asclepias sp.—*Okeechobee Co.:* in dry sandy pineland, Okeechobee City, *5426. St. Johns Co.:* in dry sandy woods near Sampson, *5290.*

Asclepiodora feayi Chapm.—*Lee Co.:* in dry sandy soil among palmettos, west of Fort Myers, *927;* in dry sandy soil of pine woods, Big Pine Island, *940a.*

Asclepiodora viridis (Walt.) A. Gray—*Dade Co.:* in dry sandy soil along roadside and in dry sandy waste ground, Buena Vista, Miami, *319, 5456;* in rich soil at edge of canal along Tamiami Trail, 25 miles west of Miami, *3768. Marion Co.:* in dry sandy soil along fence, west of Flemington, *1083b.*

Cryptostegia grandiflora R. Br.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5448, 5469.*

Epicion northropiae (Schlecht.) Small—*Monroe Co.:* climbing over low bushes at edge of hammock, north end of Key Largo, *410;* along roadside, Plantation Key, *5830.*

Metastelma blodgettii A. Gray—*Dade Co.:* in dry sandy marl, Redlands, *564;* in dry sandy pineland, Seminole Plains, Black Point, *5538.*

Philibertella clausa (Jacq.) Vail—*Monroe Co.:* climbing over low shrubs, Lower Matecumbe Key, *630;* climbing over shrubs, Cypress Lodge, Pine Crest, *5516.*

Podostigma pedicellata (Walt.) Vail—*Lee Co.:* in dry sandy soil along roadside, Coconut Grove, *5785. Orange Co.:* in dry sandy soil, Orlando, *5334.*

Seutera palustris (Pursh) Vail—*Lee Co.:* along roadside, Crescent Beach, *6490,* collected by W. M. Buswell.

RUBIACEAE

Borreria laevis (Lam.) Griseb.—*Lee Co.:* in dry sandy soil along roadside, Fort Myers, *679a,* det. Wilson; in moist sandy ditch, Fort Myers, *957,* det. Wilson.

Borreria ocimoides (Burm.) P. DC.—*Collier Co.:* in dry sandy soil along Tamiami Trail, *660,* originally distributed and det. by Wilson as *B. parviflora* Meyer. *Dade Co.:* in dry sandy waste soil, Buena Vista, Miami, *304a,* det. Wilson.

Borreria terminalis Small—*Dade Co.:* in dry sandy marl, Goulds, *398;* in moist sandy marl land, south of Florida City, *745;* in sand along roadside, Miami, *3784,* originally distributed as *B. podocephala* DC.

Casasia clusiifolia (Jacq.) Urb.—*Dade Co.:* in sand on dunes, Miami Beach, *5654.*

Cephalanthus occidentalis L.—*Dade Co.:* in wet hammock, Royal Palm Park, *838.*

Chiococca alba (L.) A. S. Hitchc.—*Monroe Co.:* in hammock, Key Largo, *5585,* collected by C. A. Mosier.

Chiococca pinetorum Britton—*Dade Co.:* in dry sandy marl, Seminole Plains, Black Point, *419a;* in waste ground, Miami, *3588;* in waste soil along roadside, Opa-Locka, *5751. Monroe Co.:* in sandy soil, Pine Crest, *362a.*

Diodia virginiana L.—*Brevard Co.:* in dry sandy soil along roadside about 8 miles west of Melbourne, *234. Collier Co.:* in dry sandy soil along Tamiami Trail, *658. Dade Co.:* at edge of Tamiami Trail, 25 miles west of Miami, *3769;* in sandy waste ground, Buena Vista, Miami, *5532.*

Erithalis fruticosa L.—*Monroe Co.:* in dry sand, Lower Matecumbe Key, *766.*

Ernodea littoralis Sw.—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *379. Monroe Co.:* in coastal sand, Sugarloaf Key, *867a.*

Galium claytonii Michx.—*Lee Co.:* in wet ditch, Fort Myers, *677.*

Galium tinctorium L.—*Duval Co.:* in dry sandy soil about 4 miles east of Eastport, *5273.*

Genipa clusiifolia (Jacq.) Griseb.—*Broward Co.:* in swamp, Lauderdale Beach, *5445.*

Guettarda scabra Vent.—*Dade Co.:* in dry sandy marl, Goulds, *541;* in Brickell Hammock, Miami, *5704.*

Hamelia erecta Jacq.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *316;* in everglades at edge of hammock, along Tamiami Trail, 25 miles west of Miami, *3770.*

Houstonia angustifolia Michx.—*Lee Co.:* in dry sandy soil, Bokeelia, *692, 935.*

Houstonia filifolia (A. Gray) Small—*Dade Co.:* in dry sandy marl, Seminole Plains, Black Point, *419.*

Houstonia procumbens (Walt.) Standl.—*Monroe Co.:* matted in moist sandy soil, Pine Crest, *5865.*

Houstonia rotundifolia Michx.—*Broward Co.:* on floor of hammock, Long Island, west of Davie, *5600. Dade Co.:* in dry sandy scrub, Miami, *5876. Duval Co.:* on sandy overhanging bank about 4 miles east of Eastport, *174. Volusia Co.:* in dry sand on dunes, Mosquito Inlet, *5313.*

Ixora undulata Roxb.—*Dade Co.:* in swamp, Miami, *511a.*

Morinda roioc L.—*Dade Co.:* in dry sandy soil, Miami, *512;* in hammock along Tamiami Trail, 25 miles west of Miami, *3771.*

Psychotria bacteriophila Valet.—*Dade Co.:* in cultivation, Coconut Grove, *5679.*

Psychotria nervosa Sw.—*Monroe Co.:* in hammock, Key Largo, *5588,* collected by C. A. Mosier.

Psychotria sulzneri Small—*Dade Co.:* in hammock, Comfort Canal region, Miami, *5642.*

Psychotria undata Jacq.—*Dade Co.:* in hammock, Comfort Canal region, Miami, *537;* in hammock near Miami, *3658. Okeechobee Co.:* in sandy woods near lake, Okeechobee City, *5435.*

Psychotria sp.—*Dade Co.:* in cultivation, Buena Vista, Miami, *6539.*

Randia aculeata L.—*Dade Co.:* in dry sandy marl, Goulds, *542.*

Richardia brasiliensis (Moq.) Gomez—*Brevard Co.:* in dry sandy soil along roadside near Melbourne, *5405. Jackson Co.:* along roadside, Marianna, *8343. Lee Co.:* in dry sandy soil along roadside, Fort Myers, *974. Pinellas Co.:* in moist grassy field, Clearwater, *1057a. St. Johns Co.:* in sandy soil along roadside, near Orange Dale, *5246.*

Spermacoce keyensis Small—*Monroe Co.:* in dry sandy soil along roadside, Key Largo, *612;* in dry sandy soil along roadside, Plantation Key, *635a;* in dry sandy soil, Key West, *800.*

Spermacoce tenuior (L.) Lam.—*Dade Co.:* at edge of Tamiami Trail, 25 miles west of Miami, *3772.*

Strumpfia maritima Jacq.—*Monroe Co.:* in dry sandy hammock, Lower Torch Key, *816.*

CAPRIFOLIACEAE

Nintooa japonica (Thunb.) Sweet—*Leon Co.:* climbing over shrubbery in thicket, Tallahassee, *1170,* originally distributed as *Lonicera japonica* Thunb.

Sambucus intermedia Carr.—*Glades Co.:* in sandy soil at edge of canal, Moore Haven, *1023. Okeechobee Co.:* in sandy soil along roadside, Okeechobee City, *245.*

Viburnum nudum L.—*Calhoun Co.:* in moist sandy soil at edge of woods, Myron, *1159.*

CICHORIACEAE[2]

Brachyrhampus intybaceus (Jacq.) P. DC.—*Monroe Co.:* in dry sandy soil along roadside, Upper Matecumbe Key, *762;* along roadside, Lower Matecumbe Key, *5750.* Both these collections were originally distributed as *Lactuca intybacea* Jacq.

Hieracium gronovii L.—*Duval Co.:* in sandy soil along roadside, 4 miles east of Eastport, *5260. Volusia Co.:* in dry sandy soil, near Ariel, *5319.*

Hieracium megacephalon Nash—*Brevard Co.:* in dry sandy field near Melbourne, *5391. Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *306. Hernando Co.:* in dry sandy pine woods, Brooksville, *1077. Lee Co.:* in dry sandy pine woods, Bokeelia, *903;* in dry sandy pineland, west of Fort Myers, *921. Orange Co.:* in dry sandy field about 3 miles west of Bithlo, *201a.*

Lactuca graminifolia Michx.—*Hernando Co.:* in dry sandy soil along roadside, Brooksville, *1075. Pinellas Co.:* in dry sandy waste soil, Dunedin, *5928.*

Lygodesmia aphylla (Nutt.) P. DC.—*Lee Co.:* in dry sandy pine woods near Coconut, *697. Orange Co.:* in sandy soil along roadside about 4 miles north of Winter Park, *182a.*

Sitilias caroliniana (Walt.) Raf.—*Hernando Co.:* in dry sandy pine woods, Brooksville, *1072. Pinellas Co.:* in dry sandy waste soil, Dunedin, *5927.*

Sonchus oleraceus L.—*Broward Co.:* in moist sandy ditch about 4 miles west of Davie, *5614. Lee Co.:* in dry soil along roadside, Fort Myers, *680,* originally distributed as *S. asper* (L.) All. *Monroe Co.:* in dry sandy field, Key Largo, *757.*

AMBROSIACEAE

Ambrosia elatior L.—*Glades Co.:* in dry sandy soil along roadside, Moore Haven, *1025.*

Ambrosia hispida Pursh—*Monroe Co.:* in dry sandy soil along railroad embankment, Lower Matecumbe Key, *618.*

Iva imbricata Walt.—*Dade Co.:* on shore of Bay Biscayne, Buena Vista, Miami, *5487. Orange Co.:* in dry sandy soil along roadside, Orlando, *5336.*

CARDUACEAE

Actinospermum angustifolium (Pursh) T. & G.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *302;* in sandy pineland, Miami, *3659. Lake Co.:* in open sandy woods, north of Mineola, *196. Lee Co.:* in sandy soil along railroad, Coconut, *5787. Orange Co.:* in dry sandy soil, Orlando, *5333.*

Ageratum littorale A. Gray—*Monroe Co.:* in dry sandy soil, Lower Matecumbe Key, *622.*

Ageratum littorale f. **album** Moldenke, f. nov.

A forma typica floribus albis recedit.—This form differs from the typical form of the species in its pure-white flowers. The type *(H. N. Moldenke 817a)* was collected in dry sandy soil on Big Pine Key, *Monroe Co.*, Florida, on March 20, 1930, and is deposited in the Britton Herbarium at the New York Botanical Garden. The collection was originally distributed as "*Ageratum littorale* var. *album* Hort.", but it appears that this trinomial has never yet been validly published in botanical or in horticultural literature.

Aster adnatus Nutt.—*Dade Co.:* in dry sandy marl, Seminole Plains, Black Point, *423a. Pinellas Co.:* in sandy soil along roadside, St. Petersburg, *5924.*

Aster bracei Britton—*Monroe Co.:* in dry sandy pineland, Big Pine Key, *822.*

Aster carolinianus Walt.—*Monroe Co.:* in dry sandy soil, Cypress Lodge, Pine Crest, *351. Okeechobee Co.:* in thicket, Okeechobee City, *5434. St. Johns Co.:* in sandy woods near Moultrie, *5296.*

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2 On page 86 of my paper "An annotated and classified list of H. N. Moldenke collection numbers from No. 1 to No. 11,277 inclusive" (1939) number 2578 is reported from Florida and cited as *Nabalus nanus* (Bigel.) P. DC. This is an error. The number is *Chamaesyce brasiliensis* (Lam.) Small.

Aster coridifolius Michx.—*Dade Co.:* in sandy marl, Goulds, *5736. St. Johns Co.:* in grassy plot near woods, near Orange Dale, *5248.*

Aster dumosus L.—*Dade Co.:* in dry sandy marl, Seminole Plains, Black Point, *421a. St. Johns Co.:* in grassy plot near woods, near Orange Dale, *7381.*

Aster elliottii T. & G.—*Seminole Co.:* in swampy ground about 1½ miles south of Sanford, *185.*

Aster exilis Ell.—*Broward Co.:* in sandy ditch and waste soil, Hollywood, *5655, 5657. Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3722. Volusia Co.:* in dry sand along roadside, Mosquito Inlet, *5309.*

Aster salicifolius Lam.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3812.*

Aster simmondsii Small—*Broward Co.:* in dry sandy soil along roadside, north of Long Island, *508;* in waste ground along roadside, west of Pompano, *5580. Dade Co.:* in dry sandy soil, Little River, *435;* in dry sandy pineland, Buena Vista, Miami, *5525. Lee Co.:* in dry sandy ditch, Fort Myers, *674. Monroe Co.:* in dry sandy soil, Cypress Lodge, Pine Crest, *350.*

Aster simulatus Small—*Dade Co.:* in dry sandy pineland and waste soil, Miami, *3572, 5828.*

Aster subulatus Michx.—*Seminole Co.:* in sandy soil along edge of ditch about 3 miles south of Sanford, *5345.*

Aster sulznerae Small—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3721.*

Baccharis glomerulifera Pers.—*Dade Co.:* in dry sandy soil along roadside, Buena Vista, Miami, *5521.*

Baccharis halimifolia L.—*Dade Co.:* in marshes, Miami, *3652;* in sandy soil at edge of canal, Buena Vista, Miami, *5511;* along roadside, west of Fulford, *5661.*

Berlandiera subacaulis Nutt.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *485. Lake Co.:* in open sandy woods, north of Mineola, *197. Orange Co.:* in sandy woods about 3 miles north of Winter Park, *5339.*

Berlandiera tomentosa T. & G.—*Columbia Co.:* in dry sandy woods, north of High Springs, *1101. St. Johns Co.:* in dry sandy woods, near Moultrie, *176.*

Bidens coronata (L.) Fisch.—*Duval Co.:* in moist sandy soil and in ditch along roadside about 4 miles east of Eastport, *172, 172a.*

Bidens leucantha (L.) Willd.—*Dade Co.:* in waste ground, Miami, *3590. Duval Co.:* in moist sandy soil, South Jacksonville, *168.*

Bidens nashii Small—*Broward Co.:* growing in about 2 feet of water, west of Pompano, *462. Highlands Co.:* in wet ditch, near Childs, *240.*

Borrichia arborescens (L.) P. DC.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3779. Monroe Co.:* in sandy soil, Upper Matecumbe Key, *759,* originally distributed as "*B. frutescens* (L.) DC."

Borrichia frutescens (L.) P. DC.—*Dade Co.:* in dry sandy soil at edge of canal, near Fulford, *392,* originally distributed as "*B. arborescens* (L.) DC." *Duval Co.:* in sandy soil along roadside, about 4 miles east of Eastport, *5287. Monroe Co.:* at edge of swamp, Lower Matecumbe Key, *5738.*

Carphephorus corymbosus (Nutt.) T. & G.—*Collier Co.:* in sandy soil near Naples, *481b,* collected by C. A. Mosier. *Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3777.*

Chamomilla inodora (L.) Gilib.—*Leon Co.:* in dry sandy soil along roadside, Tallahassee, *1171a,* originally distributed as *Matricaria inodora* L.

Chaptalia tomentosa Vent.—*Orange Co.:* in sandy bog about 3 miles west of Bithlo, *203.*

Chondrophora nudata (Michx.) Britton—*St. Johns Co.:* in dry sandy pine woods near Orange Dale, *164.*

Chrysopsis mariana (L.) Ell.—*Duval Co.:* in sandy soil along street, South Jacksonville, *5258.*

Chrysopsis scabrella T. & G.—*Dade Co.:* in sandy soil, Miami, *3654.*

Cirsium horridulum Michx.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3778.*

Cirsium nuttallii P. DC.—*Glades Co.:* in dry sandy soil, Moore Haven, *1027.*

Cirsium smallii Britton—*Dade Co.:* in everglades, Big Bend, west of Tamiami Trail, *850. Monroe Co.:* in dry sandy pineland, Cudjoe Key, *814.*

Cirsium vittatum Small—*Dade Co.:* in dry sandy marl, Goulds, *740.*

Conoclinium coelestinum (L.) P. DC.—*Dade Co.:* in dry sandy soil, south of Florida City, *747. Jackson Co.:* in moist ditch, Marianna, *8351.*

Conoclinium dichotomum Chapm.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3774.*

Coreopsis crassifolia Ait.—*Calhoun Co.:* in dry sandy pineland, north of Myron, *1157.*

Coreopsis drummondii (D. Don) T. & G.—*Gulf Co.:* in dry sandy soil, apparently escaped from cultivation, Apalachicola, *1137.*

Coreopsis gladiata Walt.—*Brevard Co.:* in sandy bog about 8 miles west of Melbourne, *223. Orange Co.* in sandy bog about 3 miles west of Bithlo, *208. St. Johns Co.:* in sandy bog near Orange Dale, *165.*

Coreopsis leavenworthii T. & G.—*Brevard Co.:* in sandy bog about 8 miles west of Melbourne, *228. Dade Co.:* in moist sandy prairie, Fulford, *579. Lee Co.:* in wet sandy soil, Fort Myers, *5775. Monroe Co.:* in everglades, Pine Crest, *366.*

Coreopsis nudata Nutt.—*Wakulla Co.:* in wet sandy soil, Medart, *1122.*

Cosmos sulphureus Cav.—*Duval Co.:* escaped along roadside, Florida Beach, *5235. Jackson Co.:* in cultivation, Marianna, *8356.*

Doellingeria reticulata (Pursh) Greene—*Duval Co.:* in sandy soil along roadside, South Jacksonville, *5253. Manatee Co.:* in moist sandy soil along fence about 5 miles north of Parrish, *1050. Orange Co.:* in dry sandy field about 3 miles west of Bithlo, *200. Sarasota Co.:* in dry sandy woods about 8 miles southeast of Venice, *1036a.*

Elephantopus tomentosus L.—*Seminole Co.:* in sandy soil along roadside about 3 miles south of Sanford, *5344.*

Emilia coccinea (Sims) Sweet—*Brevard Co.:* in dry sandy soil along roadside about 8 miles west of Melbourne, *235.*

Erechtites hieracifolia (L.) Raf.—*Dade Co.:* in rich moist soil south of Florida City, *744;* in everglades along Tamiami Trail, 25 miles west of Miami, *3775.*

Erigeron quercifolius Lam.—*Brevard Co.:* in dry sandy soil along roadside about 8 miles west of Melbourne, *225. Collier Co.:* in dry sandy marl along Tamiami Trail, *663. Dade Co.:* in moist sandy field, Redlands, *567;* in waste sandy soil, Miami, *3655;* in dry sandy waste soil, Goulds, *5735.*

Erigeron ramosus (Walt.) B.S.P.—*Leon Co.:* in dry sandy soil, Tallahassee, *1119.*

Erigeron vernus (L.) T. & G.—*Dade Co.:* in dry sandy pineland, Uleta, *892. Lee Co.:* in moist sandy soil, East Fort Myers, *987. St. Johns Co.:* in wet sandy ditch near Sampson, *175b.*

Erigeron sp.—*Broward Co.:* in waste ground along roadside, Hollywood, *5656.*

Erlangea incana S. Moore—*Dade Co.:* in cultivation, Miami, *3776.*

Eupatorium capillifolium (Lam.) Small—*Dade Co.:* in dry sandy soil near Bay Biscayne, Buena Vista, Miami, *780, 5489. Jackson Co.:* abundant in fields, Marianna, *8353.*

Eupatorium compositifolium Walt.—*Dade Co.:* in dry sandy soil along roadside, Miami, *3589.*

Eupatorium coronopifolium Willd.—*Orange Co.:* in dry sandy woods, south of Wekiva Springs, *5356.*

Eupatorium jucundum Greene—*Broward Co.:* at edge of hammock, Long Island, west of Davie, *505a. Volusia Co.:* in dry sandy soil, Mosquito Inlet, *5314.*

Eupatorium mikanioides Chapm.—*Lee Co.:* in dry sandy waste ground, Coconut, *5891;* in sandy pineland, Boca Grande, *6484*, collected by W. M. Buswell.

Eupatorium recurvans Small—*Sarasota Co.:* in dry sandy soil along roadside about 8 miles southeast of Venice, *5915*.

Eupatorium villosum Sw.—*Dade Co.:* at edge of Brickell Hammock, Miami, *524*.

Facelis apiculata Cass.—*Calhoun Co.:* in dry soil along roadside, Myron, *5976*.

Flaveria linearis Lag.—*Dade Co.:* in dry sandy soil near Bay Biscayne, Buena Vista, Miami, *305, 575;* in waste sandy soil, Miami, *3656*. *Orange Co.:* in sandy bog about 2 miles east of Fort Christmas, *213*.

Gaillardia aristata Pursh—*Volusia Co.:* in dry sandy soil along roadside near Mosquito Inlet, *178*.

Garberia fruticosa (Nutt.) A. Gray—*Lake Co.:* in sandy ditch along roadside, near Tavares, *5364*.

Gnaphalium falcatum Lam.—*Palm Beach Co.:* in dry sandy soil along roadside, South Bay, *738a*.

Gnaphalium obtusifolium L.—*Lake Co.:* in dry sandy woods, near Astatula, *5368*.

Gnaphalium purpureum L.—*Collier Co.:* in rich moist soil of clearing, Turner's River Hammock, *5767*.

Gnaphalium spathulatum Lam.—*Palm Beach Co.:* in dry sandy soil along roadside, South Bay, *738c*.

Gynura aurantiaca P. DC.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5458*.

Helenium leptopoda Wood—*Broward Co.:* in moist sandy soil, west of Pompano, *392a*. *Dade Co.:* in moist sandy marl, west of Goulds, *641*.

Helenium nudiflorum Nutt.—*Dade Co.:* in dry sandy marl, Goulds, *539*.

Helenium tenuifolium Nutt.—*Gadsden Co.:* in dry sandy soil, east of Havana, *1166*. *Jackson Co.:* in dry field, Marianna, *8355*. *Orange Co.:* in sandy soil at edge of woods about 3 miles north of Winter Park, *5338*.

Helenium vernale Walt.—*Wakulla Co.:* in grassy bog, Medart, *1125*, determined by Rydberg and originally distributed as *H. pinnatifidum* (Schw.) Rydb.

Helenium sp.—*Dade Co.:* in dry sandy pineland, Seminole Plains, Black Point, *5540*.

Helianthus argophyllus T. & G.—*Monroe Co.:* in junk pile, Key West, *5842*.

Helianthus debilis Nutt.—*Brevard Co.:* in dry sandy soil, Merritt's Island, *219*. *Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3773*.

Helianthus radula (Pursh) T. & G.—*St. Johns Co.:* in sandy woods near Moultrie, *5297*, originally distributed as *Arnica acaulis* (Walt.) B.S.P.

Heterotheca subaxillaris (Lam.) Britton & Rusby—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5533*. *Duval Co.:* in dry sandy woods about 4 miles east of Eastport, *5265*. *Lee Co.:* in sandy pineland, Fort Myers, *1383*, collected by W. M. Buswell.

Hymenopappus carolinensis (Lam.) Porter—*Marion Co.:* in dry sandy woods east of Flemington, *1084*.

Isopappus divaricatus (Nutt.) T. & G.—*Jackson Co.:* abundant in field, Marianna, *8352*.

Laciniaria chapmanii (T. & G.) Kuntze—*Broward Co.:* in dry sandy pineland, west of Pompano, *483a*.

Laciniaria elegans (Walt.) Kuntze—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *6540*.

Laciniaria garberi (A. Gray) Kuntze—*Glades Co.:* in sandy pineland, near Citrus Center, *8397*.

Laciniaria gracilis (Pursh) Kuntze—*Broward Co.:* in dry sandy pineland west of Pompano, *485a*.

Laciniaria laxa Small—*Dade Co.:* in dry sandy pineland, South Miami, *5858. Orange Co.:* in dry sandy woods south of Wekiva Springs, *192a.*

Laciniaria tenuifolia (Nutt.) Kuntze—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *484a;* in sandy pineland, Miami, *3646.*

Leptilon canadense (L.) Britton—*Lee Co.:* in waste ground, East Fort Myers, *986.*

Melanthera angustifolia A. Rich.—*Collier Co.:* in dry sandy marl south of Tamiami Trail, *875. Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3727. Monroe Co.:* in dry sandy soil, Pine Crest, *361.*

Melanthera deltoidea Michx.—*Broward Co.:* in dry sandy soil, Lauderdale Beach, *262. Dade Co.:* in dry sandy soil, Miami Beach, *382. Monroe Co.:* in dry sandy soil along roadside, Plantation Key, *637;* in dry sandy soil along roadside, Key West, *793. Palm Beach Co.:* in dry sandy soil along roadside about 2 miles north of Canal Point, *252.*

Melanthera parviflora Small—*Dade Co.:* in sandy waste soil, Miami, *3697.*

Melanthera radiata Small—*Dade Co.:* in dry sandy soil of pineland, Buena Vista, Miami, *309, 5475, 5796, 5801, 5811;* in dry sandy soil of pineland, Miami, *711, 720.*

Mesadenia lanceolata (Nutt.) Raf.—*Dade Co.:* in moist sandy marl, South Miami, *728, 826. Hernando Co.:* in sandy ditch along roadside, Brooksville, *5944.*

Mikania batatifolia P. DC.—*Broward Co.:* climbing over tall weeds in hammock, west of Pompano, *465. Volusia Co.:* climbing over weeds, near Ariel, *180.*

Mikania scandens (L.) Willd.—*Dade Co.:* climbing over tall weeds at edge of canal along Tamiami Trail, 25 miles west of Miami, *3813.*

Osmia frustrata (B. L. Robinson) Small—*Collier Co.:* in clearing, Turner's River Hammock, *5770. Dade Co.:* in waste ground by old avocado orchard, Buena Vista, Miami, *5459. Monroe Co.:* in sandy soil, Lower Matecumbe Key, *623.*

Osmia odorata (L.) Schultz-Bip.—*Dade Co.:* in grassy orchard, Buena Vista, Miami, *289.*

Parthenium hysterophorus L.—*Jackson Co.:* along roadside, Marianna, *8341. Monroe Co.:* in dry sandy soil, Key West, *794, 800a.*

Pectis leptocephala (Cass.) Urb.—*Dade Co.:* in dry sandy marl, Silver Bluff, *728a;* in dry sandy pineland, Miami, *3698.*

Phaethusa virginica (L.) Britton—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3726. Martin Co.:* in dry sandy soil at edge of swamp about 1 mile north of Fort Mayaca, *5439.*

Pityopsis graminifolia (Michx.) Nutt.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *329. Orange Co.:* in dry sandy soil along roadside about 3 miles north of Winter Park, *5342.* Both these collections were originally distributed as *Chrysopsis graminifolia* (Michx.) Ell.

Pityopsis oligantha (Chapm.) Small—*Wakulla Co.:* in dry sandy pineland, south of Sopchoppy, *1128,* originally distributed as *Chrysopsis oligantha* Chapm.

Pityopsis tracyi (Small) Small—*Dade Co.:* in dry sandy soil among palmettos and in dry sandy pineland, Buena Vista, Miami, *287, 296a;* in dry sandy marl, Seminole Plains, Black Point, *420;* in waste sandy ground, Miami, *3653. Lee Co.:* in sandy soil along roadside, Coconut, *5778. Monroe Co.:* in dry sandy pineland, Big Pine Key, *819. Orange Co.:* in dry sandy soil along roadside about 3 miles west of Bithlo, *204.* All these collections were originally distributed as *Chrysopsis tracyi* Small.

Pluchea camphorata (L.) P. DC.—*Dade Co.:* in sandy soil of waste patch, Miami, *3699.*

Pluchea foetida (L.) B.S.P.—*Clay Co.:* in dry sandy soil about 2 miles north of Orange Park, *5241. Dade Co.:* in moist sandy soil, Goulds, *742;* in dry sandy pineland, Little River, *5561,* originally distributed as "*P. purpurascens* (Sw.) DC."

Pluchea odorata Cass.—*Dade Co.:* in dry sandy soil along roadside, Coconut Grove, *731.*

Pluchea petiolata Cass.—*Jackson Co.:* in moist ditch, Marianna, *8358. Lee Co.:* in moist sandy ditch, East Fort Myers, *992.*

Pluchea purpurascens (Sw.) P. DC.—*Brevard Co.:* in dry sandy soil along roadside about 8 miles west of Melbourne, *229a. Dade Co.:* in rich moist soil along Tamiami Trail, *337;* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3725. Monroe Co.:* in moist sandy soil, Lower Torch Key, *817.*

Polypteris integrifolia Nutt.—*Duval Co.:* in sandy soil about 4 miles east of Eastport, *5263.*

Pterocaulon undulatum (Walt.) C. Mohr—*Brevard Co.:* in dry sandy soil, Merritt's Island, *237. Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *334a;* in dry sandy marl, Seminole Plains, Black Point, *421.* These three collections were originally distributed as "*P. undulatum* (Walt.) Ell."

Rudbeckia fulgida Ait.—*Jackson Co.:* along roadside, Marianna, *8340.*

Rudbeckia hirta L.—*Lee Co.:* in dry sandy soil, Coconut, *703. Osceola Co.:* in dry sandy soil along roadside, west of Deer Park, *235a.*

Senecio lobatus Pers.—*Collier Co.:* in rich moist soil, Turner's River Hammock, *667. Glades Co.:* in moist sandy ditch, Citrus Center, *1022a;* in moist sandy prairie, Moore Haven, *1024.*

Sericocarpus bifoliatus (Walt.) Porter—*Lee Co.:* in dry sandy pineland, Coconut, *5893.*

Silphium asteriscus L.—*Lee Co.:* in dry sandy pine woods, Salvista, *1032b.*

Silphium ovatifolium (T. & G.) Small—*Marion Co.:* in dry sandy woods, Irvine, *1088a.*

Solidago altissima L.—*Jackson Co.:* along fencerow, Marianna, *8349.*

Solidago chapmanii T. & G.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *270a, 313;* in dry sandy soil at edge of Arch Creek Hammock, *394;* in sandy field, Miami, *3700.*

Solidago fistulosa Mill.—*Dade Co.:* at edge of Opa-Locka Hammock, *493;* at edge of small hammock along Tamiami Trail, 25 miles west of Miami, *3724;* in dry sandy pineland west of Fulford, *5576.*

Solidago leavenworthii T. & G.—*Broward Co.:* in dry sandy prairie, Long Island, west of Davie, *5607. Dade Co.:* in dry sandy soil, Miami, *739;* in dry sandy pineland, Uleta, *893. Monroe Co.:* along roadside, Pine Crest, *5517.*

Solidago sempervirens var. *mexicana* (L.) Fernald—*Dade Co.:* in dry sandy soil near Fulford, *389;* in moist sandy soil, Little River, *528;* in sandy soil and pineland, Buena Vista, Miami, *5486, 5871a. Lee Co.:* in moist sandy soil, Coconut, *964;* in dry sandy ditch, Big Pine Island, *5884. Monroe Co.:* in dry sandy soil near Pine Crest, *368;* in dry sandy marl, Cape Sable region, *836.* All these collections were originally distributed as *S. mexicana L.*

Solidago stricta Ait.—*Dade Co.:* in dry sandy pineland, Buena Vista, *270;* in dry sandy pineland, Miami, *3701.*

Spilanthes repens (Walt.) Michx.—*Collier Co.:* in dry sandy marl along Tamiami Trail, *661.*

Tetragonotheca helianthoides L.—*Marion Co.:* in dry sandy woods, east of Flemington, *1085.*

Tithonia diversifolia (Hemsl.) A. Gray—*Dade Co.:* in dry sandy waste ground, apparently escaped from cultivation, Buena Vista, Miami, *433.*

Tridax procumbens L.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *266;* in sandy waste ground, Miami, *3584.*

Trilisa odoratissima (Walt.) Cass.—*Dade Co.:* in dry sandy field, Miami, *332a.*

Trilisa paniculata (Walt.) Cass.—*St. Johns Co.:* in dry sandy woods, near Orange Dale, *163.*

Verbesina alba L.—*Broward Co.:* in rich cultivated soil, west of Pompano, *477. Collier Co.:* along edge of Tamiami Trail, *5760. Dade Co.:* in waste cultivated ground, west of Fulford, *5663.*

Vernonia blodgettii Small—*Dade Co.:* in dry sandy marl, Goulds, *396;* in dry

sandy pineland, Ulete, *893a;* in everglades at edge of canal along Tamiami Trail, 25 miles west of Miami, *3723;* in dry sandy pineland, Buena Vista, Miami, *5523.*

Vernonia gigantea (Walt.) Trelease—*St. Johns Co.:* in dry sandy field, St. Augustine, *167.*

Wedelia trilobata (L.) A. S. Hitchc.—*Dade Co.:* in dry sandy soil, Buena Vista, Miami, *292;* in waste ground, escaped from cultivation, Miami, *3702.*

Zinnia multiflora L.—*Orange Co.:* in dry sandy soil along roadside, Orlando, *5327. Seminole Co.:* in sandy soil along roadside about 3 miles south of Sanford, *5346.*

GENTIANACEAE

Bartonia verna (Michx.) Muhl.—*Orange Co.:* in sandy bog about 3 miles west of Bithlo, *205.*

Eustoma exaltatum (L.) Griseb.—*Monroe Co.:* in dry sandy soil, Lower Matecumbe Key, *763a;* in dry sandy soil, No Name Key, *808.*

Sabbatia brachiata Ell.—*Brevard Co.:* in wet sandy soil, near Melbourne, *5394.*

Sabbatia campanulata (L.) Torr.—*Broward Co.:* in dry sandy marl, Hollywood, *594. Collier Co.:* in everglades along Tamiami Trail, *900. Monroe Co.:* in dry sandy soil, Ramrod Key, *815a. Orange Co.:* in sandy bog about 2 miles east of Fort Christmas, *210.*

Sabbatia elliottii Steud.—*Clay Co.:* in sandy soil along roadside about 2 miles north of Orange Park, *162. Lee Co.:* in dry sandy pineland, south of Fort Myers, *909.*

Sabbatia grandiflora (A. Gray) Small—*Lee Co.:* in moist sandy pineland near Coconut, *969a. Volusia Co.:* in moist sandy ditch near Ariel, *180a.*

MENYANTHACEAE

Nymphoides aquaticum (Walt.) Kuntze—*Monroe Co.:* in everglades, Pine Crest, *654.*

PRIMULACEAE

Samodia ebracteata (H.B.K.) Baudo—*Collier Co.:* in everglades along Tamiami Trail, *303. Hernando Co.:* in moist sandy ditch south of Aripeka, *1065a. Monroe Co.:* in everglades, Pine Crest, *361a. Orange Co.:* in sandy soil along roadside about 2 miles east of Fort Christmas, *211. Pasco Co.:* in dry sandy soil along ditch, Hudson, *1064.*

Samolus floribundus H.B.K.—*Dade Co.:* in everglades along Tamiami Trail, *551. Lee Co.:* in wet ditch, Fort Myers, *5772;* in wet sandy ditch, Rialto, *5908. Sarasota Co.:* in moist sandy ditch north of Venice, *1040.*

PLUMBAGINACEAE

Plumbago capensis Thunb.—*Dade Co.:* in cultivation, Miami, *3647. Orange Co.:* in cultivation, Orlando, *5324.*

Plumbago scandens L.—*Dade Co.:* sprawling over shrubs in moist soil, Brickell Hammock, Miami, *722, 725a.*

PLANTAGINACEAE

Plantago virginica L.—*Pinellas Co.:* in dry sandy soil along roadside, St. Petersburg, *1056.*

CAMPANULACEAE

Rothana floridana (S. Wats.) Small—*Lee Co.:* climbing over low vegetation in moist ditch, Coconut, *696,* originally distributed as *Campanula floridana* S. Wats.

Specularia biflora (Ruíz & Pav.) F. & M.—*Marion Co.:* in dry sandy ditch along roadside west of Flemington, *1083a.*

Specularia perfoliata (L.) A. DC.—*Hernando Co.:* in moist sandy ditch, Brooksville, *1032.*

LOBELIACEAE

Lobelia feayana A. Gray—*Lee Co.:* in moist sandy ditch along roadside, Coconut, *695. Orange Co.:* in sandy bog about 2 miles east of Fort Christmas, *5384.*

Lobelia glandulosa Walt.—*Brevard Co.:* in moist sandy ditch near Melbourne, *5398. Monroe Co.:* in everglades, Pine Crest, *357. Orange Co.:* in sandy bog about 3 miles

west of Bithlo, *207*. *Osceola Co.:* in bog, Deer Park *5409*. *Seminole Co.:* in wet ditch about 1½ miles south of Sanford, *5348*.

Lobelia homophylla F. E. Wimmer—*Lee Co.:* in moist sandy ditch west of Fort Myers, *920;* in moist sandy ditch, Rialto, *1010*. Both these collections were originally distributed and were cited in my "An annotated and classified list of H. N. Moldenke collection numbers from no. 1 to no. 11,277, inclusive," page 100 (1939), as *L. xalapensis* H.B.K.

Lobelia paludosa Nutt.—*Lee Co.:* in moist sandy ditch, Big Pine Island, *505*.

Lobelia sp.—*Monroe Co.:* in dry sandy soil at edge of everglades, Pine Crest, *5518*.

GOODENIACEAE

Scaevola plumieri Vahl—*Dade Co.:* Buena Vista, Miami, *5479*. *Monroe Co.:* in dry sandy soil at edge of hammock, Lower Matecumbe Key, *628*.

POLEMONIACEAE

Phlox drummondii Hook.—*Alachua Co.:* in sandy waste soil along roadside, extensively escaped from cultivation, Gainesville, *1095*, det. Wherry. *Gulf Co.:* in dry sandy soil, apparently naturalized, Apalachicola, *1139a*, det. Wherry; in dry sandy soil along roadside, Apalachicola, *5973*, det. Wherry. *Hernando Co.:* along roadside, Brooksville, *5942*, det. Wherry. *Levy Co.:* in dry sandy ditch, extensively naturalized, south of Morriston, *1082b*, det. Wherry. *Madison Co.:* in dry sandy ditch, extensively naturalized, west of Greenville, *1110a*, det. Wherry. *Marion Co.:* in sandy ditch, apparently naturalized, east of Flemington, *1086a*, det. Wherry. *Pasco Co.:* in dry sandy soil along roadside, extensively naturalized, New Port Richey, *1062a*, det. Wherry.

Phlox glaberrima var. *melampyrifolia* (Salisb.) Wherry—*Gadsden Co.:* in dry grassy swale near brook, Chattahootchee, *1164*, det. Wherry, originally distributed as *P. glaberrima* L.

Phlox nivalis Lodd.—*Columbia Co.:* in sandy woodland, north of High Springs, *1100*, det. Wherry. *Manatee Co.:* in dry sandy pine woods about 5 miles north of Parrish, *1051*, det. Wherry. *Marion Co.:* in dry sandy woods, Irvine, *1090a*, det. Wherry. *Pasco Co.:* in dry sandy woods, Elfers, *1061a*, det. Wherry, *5930*, det. Wherry.

Phlox pilosa var. *detonsa* A. Gray—*Hernando Co.:* in dry sandy woods southwest of Brooksville, *1069*, det. Wherry; in dry open woods, Brooksville, *1071*, det. Wherry. *Leon Co.:* in dry sandy woods, Tallahassee, *1111a*, det. Wherry. *Madison Co.:* in dry sandy soil along roadside near Ellaville, *1106a*, det. Wherry. *Suwannee Co.:* in sandy clearing at edge of woods, Houseton, *1105*, det. Wherry.

Phlox pilosa var. *virens* (Michx.) Wherry—*Wakulla Co.:* in sandy field and dry sandy woods, Wakulla, *1120a*, det. Wherry, *5964*, det. Wherry.

BORAGINACEAE

Batschia caroliniensis (Walt.) J. F. Gmel.—*Jackson Co.:* in dry sandy oak woods east of Marianna, *1162*, originally distributed as *Lithospermum carolinense* (Walt.) MacM.

Onosmodium virginianum (L.) P. DC.—*Hernando Co.:* in sandy woods, Brooksville, *1081*.

EHRETIACEAE

Bourreria ovata Miers—*Monroe Co.:* in hammock, Lower Matecumbe Key, *629;* at edge of hammock, Upper Matecumbe Key, *5831*.

Bourreria revoluta H.B.K.—*Monroe Co.:* in hammock, north end of Key Largo, *417a*.

Cordia sebestena L.—*Dade Co.:* in cultivation, Coconut Grove, *5697*. *Monroe Co.:* in hammock along roadside, Upper Matecumbe Key, *757a;* at edge of hammock, Lower Matecumbe Key, *5821*.

Varronia globosa Jacq.—*Dade Co.:* along roadside, Buena Vista, Miami, *5502*.

HELIOTROPIACEAE

Cochranea anchusaefolia (Poir.) Gürke—*Alachua Co.:* in dry sandy soil, Gainesville, *1094*.

Heliotropium horizontale Small—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *815.*

Heliotropium leavenworthii Torr.—*Brevard Co.:* in dry sandy soil along roadside about 8 miles west of Melbourne, *231. Dade Co.:* in moist sandy soil on prairies near Hialeah, *295a;* in dry sandy soil along roadside, Buena Vista, Miami, *327a.*

Heliotropium polyphyllum Lehm.—*Collier Co.:* in moist sandy pine woods, East Naples, *907. Lee Co.:* in dry sandy field, Fort Myers, *681.*

Mallotonia gnaphaloides (Jacq.) Britton—*Broward Co.:* in sand on coastal sand-dunes, Lauderdale Beach, *263,* originally distributed as *Tournefortia gnaphaloides* (Jacq.) R. Br.

Myriopus volubilis (L.) Small—*Monroe Co.:* climbing over low shrubs at edge of hammock, north end of Key Largo, *412,* originally distributed as *Tournefortia volubilis* L.

Schobera angiosperma (J. Murray) Britton—*Dade Co.:* in sandy soil along roadside, Miami, Beach, *383;* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3734. Monroe Co.:* in dry sandy soil, Big Pine Key, *806.* These three collections were originally distributed and are cited in my Annotated List (p. 101) as *Heliotropium parviflorum* L.

Tournefortia hirsutissima L.—*Dade Co.:* in Cox Hammock, west of Goulds, *5753. Monroe Co.:* in dry sandy soil at edge of canal near Pine Crest, *861.*

SOLANACEAE

Capsicum annuum L.—*Dade Co.:* persistent after cultivation, Miami, *3637.*

Capsicum baccatum L.—*Dade Co.:* in Brickell Hammock, *727.*

Capsicum frutescens L.—*Dade Co.:* in Brickell Hammock, Miami, *318a.*

Cestrum diurnum L.—*Dade Co.:* in dry sandy pineland near Bay Biscayne, Buena Vista, Miami, *258;* in cultivation, Miami, *3636.*

Cestrum nocturnum L.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5477.*

Lycium carolinianum Walt.—*Monroe Co.:* in wet soil at edge of canal, Lower Matecumbe Key, *617.*

Nicotiana plumbaginifolia Viv.—*Monroe Co.:* in dry sandy soil along roadside, Key West, *791a,* det. Goodspeed, originally distributed as *N. longiflora* Cav.

Physalis angustifolia Nutt.—*Collier Co.:* in dry sandy soil, Caxambas, *1006,* det. Rydberg. *Dade Co.:* in dry sandy soil along roadside, Big Bend, west of Tamiami Trail, *852,* det. Rydberg; in dry sandy pineland, south of Florida City, *5817. Monroe Co.:* in dry sandy soil, Pine Crest, *858a,* det. Rydberg.

Physalis arenicola Kearney—*Marion Co.:* in dry sandy ditch, Irvine, *1090,* det. Rydberg.

Physalis barbadensis Jacq.—*Broward Co.:* at edge of hammock, west of Pompano, *480,* det. Rydberg. *Dade Co.:* in waste soil along roadside, Miami, *3641.*

Physalis ciliosa Rydb.—*Hendry Co.:* in dry sandy ditch, Labelle, *1018,* det. Rydberg. *Lee Co.:* in dry sandy soil of field, Fort Myers, *944a,* det. Rydberg, *946,* det. Rydberg; in dry sandy waste soil, Fort Myers, *5885.*

Physalis elliottii Kunze—*Brevard Co.:* in dry sandy soil near Melbourne, *5395. Broward Co.:* in dry sandy soil west of Pompano, *479,* det. Rydberg. *Collier Co.:* in dry sandy soil along roadside along Tamiami Trail, *663a,* det. Rydberg. *Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *384,* det. with question-mark by Rydberg, *391,* det. Rydberg; in dry sandy soil along roadside, Miami Beach, *391a,* det. Rydberg; in moist sandy ditch, Little River, *530,* det. Rydberg; in moist sandy pineland, Miami, *712,* "intermediate, varying to *P. viscosa,*" according to Rydberg; in dry sandy pineland, Buena Vista, Miami, *715,* det. Rydberg, *5520;* at edge of Tamiami Trail, 25 miles west of Miami, *3733. Lee Co.:* in moist sandy ditch west of Fort Myers, *922a,* det. with a question-mark by Rydberg and the comment "intermediate"; in moist ditch, Coconut, *698a,* det. Rydberg; in dry sandy soil, Bonita Beach, *975,* det. Rydberg. *Monroe Co.:* in dry sandy soil near Pine Crest, *368a,* "intermediate, varying to *P. angustifolia,*" according to Rydberg.

Physalis intermedia Rydb.—*Collier Co.:* at edge of Tamiami Trail, *5761.*

Physalis viscosa L.—*Highlands Co.:* in dry sandy soil along roadside, near Childs, *5417. Volusia Co.:* in sand on coastal sand-dunes, near Mosquito Inlet, *177.*

Solandra guttata D. Don—*Dade Co.:* in cultivation, Miami, *3574.*

Solanum adventitium Polgár—*Broward Co.:* in rich cultivated soil north of Long Island, *507*, det. Blom, originally distributed and cited in my Annotated List (p. 103) as *S. nigrum* L. The species is not recorded in Small's Manual.

Solanum bahamense L.—*Broward Co.:* in sandy soil, Lauderdale Beach, *261.*

Solanum blodgettii Chapm.—*Dade Co.:* at edge of hammock, south of Florida City, *748.*

Solanum carolinense L.—*Jackson Co.:* in dry field, Marianna, *8360. Leon Co.:* in dry sandy soil at edge of thicket, Tallahassee, *1118. Okeechobee Co.:* in dry sandy soil near lake, Okeechobee City, *5432.*

Solanum gracile Link—*Collier Co.:* in dry sandy soil along roadside, south of Tamiami Trail, *874.*

Solanum nigrum L.—*Duval Co.:* in waste ground, South Jacksonville, *5256. Monroe Co.:* in dry sandy soil along roadside, Pine Crest, *867a. Orange Co.:* in sandy soil along roadside about 2 miles east of Fort Christmas, *5385.*

Solanum nodiflorum Jacq.—*Dade Co.:* in old rock pit, Buena Vista, Miami, *442*, det. Blom, originally distributed and cited in my Annotated List (p. 103) as *S. nigrum* L. The species is not recorded in Small's Manual.

Solanum seaforthianum H. C. Andr.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5649.*

Solanum verbascifolium L.—*Dade Co.:* in dry soil along roadside, Miami, *3638. Okeechobee Co.:* in dry sandy soil along roadside, Okeechobee City, *246.*

CONVOLVULACEAE

Calonyction aculeatum (L.) House—*Monroe Co.:* in sand along railroad embankment, Upper Matecumbe Key, *758.*

Calonyction tuba (Schlecht.) Colla—*Dade Co.:* in sand near Bay Biscayne, Buena Vista, Miami, *321.*

Convolvulus repens L.—*Dade Co.:* climbing over tall weeds at edge of canal, east of Big Bend, along Tamiami Trail, *338. Palm Beach Co.:* climbing over tall weeds in dry sandy soil along roadside, Bell Glade, *737.*

Evolvulus sericeus Sw.—*Lee Co.:* in dry sandy pineland, Fort Myers, *5773.*

Exogonium microdactylum (Griseb.) House—*Dade Co.:* in dry sandy pineland, Goulds, *5535*, originally distributed as "*E. microdactylon* Choisy."

Ipomoea batatas (L.) Lam.—*Okeechobee Co.:* in waste ground, Okeechobee City, *5428.*

Ipomoea cairica Sweet—*Dade Co.:* in dry sandy soil on waste ground, Buena Vista, Miami, *278. St. Johns Co.:* trailing along roadside, near Orange Dale, *5247.*

Ipomoea pes-caprae (L.) Sweet—*Broward Co.:* trailing in sand on coastal sand-dunes, Lauderdale Beach, *258a. Dade Co.:* in cultivation, Miami, *3639.*

Ipomoea quinquefolia L.—*Dade Co.:* in dry sandy soil along roadside, Coral Gables, *701, 708.*

Ipomoea sagittata Cav.—*Dade Co.:* climbing over tall weeds at edge of canal, south of Florida City, *749;* twining over weeds at edge of canal along Tamiami Trail, 25 miles west of Miami, *3811. Monroe Co.:* climbing over *Mariscus jamaicensis* in water of everglades, Pine Crest, *855a.*

Ipomoea stolonifera (Cirillo) Poir.—*Dade Co.:* creeping in sand, Miami Beach, *388a. Duval Co.:* in sand on dunes, Florida Beach, *5234. Volusia Co.:* creeping in dune sand along roadside, Mosquito Inlet, *5305.*

Ipomoea tiliacea (Willd.) Choisy—*Dade Co.:* in dry sandy pineland, Goulds, *5536.*

Ipomoea triloba L.—*Monroe Co.:* in dry sandy waste ground, Key West, *5835.*

Jacquemontia curtissii Peter—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *272;* in dry sandy pineland, Seminole Plains, Black Point, *420a.*

Jacquemontia pentantha (Jacq.) G. Don—*Monroe Co.:* climbing over weeds at edge of road, Cypress Lodge, Pine Crest, *341;* in sand along roadside, Lower Matecumbe Key, *782;* climbing over bushes along roadside, Key West, *5839.*

Jacquemontia reclinata House—*Dade Co.:* in sand on beach, Golden Beach, *587;* in sandy pineland, Miami, *3585.*

Operculina dissecta (Jacq.) House—*Dade Co.:* in dry sandy soil on waste ground, Buena Vista, Miami, *282;* climbing over weeds at edge of canal along Tamiami Trail, 25 miles west of Miami, *3732,* originally distributed as *Ipomoea dissecta* (Jacq.) Pursh.

Operculina tuberosa (L.) Meisn.—*Dade Co.:* in cultivation, Coconut Grove, *5693,* originally distributed as *Sicania odorifera* Naud., det. as *Ipomoea tuberosa* L. by Bailey.

Pharbitis cathartica (Poir.) Choisy—*Dade Co.:* in dry sandy soil on waste ground, Buena Vista, Miami, *277, 5524;* trailing on sand of beach, Miami Beach, *380;* growing over tall weeds along roadside, Comfort Canal region, Miami, *534;* in dry sandy pineland west of Fulford, *5575. Monroe Co.:* climbing over tall weeds along roadside, Upper Matecumbe Key, *763.*

Pharbitis cathartica f. **alba** Moldenke, f. nov.—A forma typica corollis albis recedit. This form differs from the typical form of the species in having pure-white corollas. The type *(H. N. Moldenke 388)* was collected trailing on sand, Miami Beach, *Dade Co.,* Florida, on March 5, 1930, and is deposited in the Britton Herbarium at the New York Botanical Garden. The flowers are large, white, and numerous. It was originally distributed as "*P. cathartica* var. *alba* Hort." and is so cited on page 103 of my Annotated List, but the trinomial does not appear to have been validly published to date. An additional collection is no. *772,* climbing over tall weeds along roadside at edge of hammock, north end of Key Largo, *Monroe Co.,* similarly distributed and cited.

Pharbitis hederacea (L.) Choisy—*St. Johns Co.:* climbing over tall weeds along roadside, St. Augustine, *5249,* originally distributed as *Ipomoea hederacea* Jacq.

Pharbitis purpurea (L.) Voigt—*Jackson Co.:* in field, Marianna, *8347.*

Stylisma aquatica (Walt.) Chapm.—*Broward Co.:* in clearing on floor of hammock, Long Island, west of Davie, *5609. Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5650.*

Thyella tamnifolia (L.) Raf.—*Jackson Co.:* climbing along fencerow, Marianna, *8348.*

Turbinia corymbosa (L.) Raf.—*Dade Co.:* climbing over tall weeds, Buena Vista, Miami, *428;* in cultivation, Buena Vista, Miami, *5474. Monroe Co.:* trailing along edge of canal, Cypress Lodge, Pine Crest, *347.*

CUSCUTACEAE

Cuscuta americana L.—*Dade Co.:* climbing over low shrubs, Buena Vista, *372a,* det. Yuncker.

DICHONDRACEAE

Dichondra carolinensis Michx.—*Dade Co.:* forming dense lawn, Little River, *5733* [this collection was unintentionally omitted from my Annotated List]. *Leon Co.:* creeping in moist grassy field near lake, practically hidden by the grass, Tallahassee, *1116.*

SCROPHULARIACEAE

Agalinis erecta (Walt.) Pennell—*Lee Co.:* in moist sandy soil, East Fort Myers, *984,* det. Pennell.

Agalinis fasciculata (Ell.) Raf.—*Dade Co.:* at edge of Tamiami Trail, 25 miles west of Miami, *3810.*

Agalinis fasciculata var. *peninsularis* Pennell—*Glades Co.:* in boggy soil, Citrus Center, *1021,* det. Pennell.

Agalinis maritima var. *grandiflora* (Benth.) Pennell—*Lee Co.:* in moist sandy ditch, Coconut, *964a,* det. Pennell. *Monroe Co.:* in moist sandy soil, Big Pine Key,

821, det. Pennell; in dry soil along roadside, No Name Key, *822a*, det. Pennell.

Agalinis purpurea (L.) Pennell—*Collier Co.:* in dry sandy marl along Tamiami Trail, *901*, det. Pennell; in moist sandy woods, Marco Junction, *997*, det. Pennell; in moist sandy ditch, Marco, *999a*, det. Pennell.

Bramia monnieri (L.) Pennell—*Clay Co.:* in moist sandy ditch about 2 miles north of Orange Park, *159*, det. Pennell, originally distributed as *B. monniera* (L.) Drake. *Duval Co.:* in sandy ditch about 4 miles east of Eastport, *5266*.

Buchnera elongata Sw.—*Dade Co.:* in pineland, Miami, *3640*.

Buchnera floridana Gandoger—*Brevard Co.:* in dry sandy field about 2 miles west of Melbourne, *222*, det. Pennell. *Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *336*, det. Pennell. *Lee Co.:* in dry sandy pineland, Big Pine Island, *699*, det Pennell; in moist sandy soil, Bokeelia, *934*, det. Pennell. All these collections were originally distributed as *B. elongata* Sw.

Capraria biflora L.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3731;* in wet ditch, Little River, *5640*. *Monroe Co.:* in dry sandy soil along roadside, Key Largo, *417*.

Gratiola ramosa Walt.—*Monroe Co.:* growing in water of everglades, Pine Crest, *653a*, det. Pennell. *Wakulla Co.:* in moist sandy soil, Medart, *1124*, det. Pennell; in sandy bog, Wakulla, *1126a*, det. Pennell.

Hydrotrida caroliniana (Walt.) Small—*Dade Co.:* in water of everglades along Tamiami Trail, 25 miles west of Miami, *3754*. *Duval Co.:* in water of ditch about 5 miles east of South Jacksonville, *5231*.

Ilysanthes grandiflora (Nutt.) Benth.—*Lee Co.:* in wet sandy ditch, Fort Myers, *673;* in moist sandy ditch south of Estero, *963a*. *Volusia Co.:* in wet sandy ditch near Ariel, *179*.

Ilysanthes refracta Benth.—*St. Johns Co.:* in sandy pine woods near Orange Dale, *5244*.

Linaria canadensis (L.) Dumort.—*Lee Co.:* in dry sandy ditch west of Fort Myers, *919*. *Sarasota Co.:* in dry sandy soil about 8 miles southeast of Venice, *5917*.

Linaria floridana Chapm.—*Lake Co.:* in sandy soil along roadside, near Tavares, *5363*, det. Pennell, originally distributed as *L. canadensis* (L.) Dumort.

Mecardonia acuminata var. *peninsularis* Pennell—*Dade Co.:* in dry sandy marl, Goulds, *610a*, det. Pennell. *Lee Co.:* in dry sandy pineland, Fort Myers, *682*, det. Pennell; in moist sandy ditch, west of Fort Myers, *922*, det. Pennell.

Pagesia procumbens (Mill.) Pennell—*Monroe Co.:* in dry sandy waste ground, Key West, *5836*, det. Pennell.

Penstemon australis Small—*Marion Co.:* in dry sandy woods, east of Flemington, *1086*, det. Pennell; in dry sandy woods, Irvine, *1091a*, det. Pennell, originally distributed as *P. laevigatus* Soland.

Penstemon multiflorus Chapm.—*Dade Co.:* in dry sandy pineland, South Miami, *827*, det. Pennell.

Russelia juncea Zucc.—*Dade Co.:* extensively naturalized in dry sandy waste soil, Miami, *513*, originally distributed as *R. equisetiformis* Schlecht. & Cham.

Scoparia dulcis L.—*Collier Co.:* in Turner's River Hammock, *664*, det. Pennell. *Dade Co.:* in moist sandy waste ground, Miami, *710*, det. Pennell. *Lee Co.:* in dry sandy pineland, Fort Myers, *700*, det. Pennell. *Monroe Co.:* in dry sandy soil, Pine Crest, *856*, det. Pennell. *Union Co.:* in sandy soil near lake, Lake Butler, *5289*.

Sophronanthe hispida Benth.—*Lee Co.:* in dry sandy soil, Fort Myers, *945*. *Okeechobee Co.:* in dry sandy pineland, Okeechobee City, *5425*.

Torenia fournieri Linden—*Dade Co.:* in cultivation, Miami, *3797*.

LENTIBULARIACEAE

Aranella fimbriata (H.B.K.) Barnh.—*Brevard Co.:* in sandy bog about 8 miles west of Melbourne, *226*, det. Barnhart, originally distributed as *Setiscapella subulata* (L.) Barnhart.

Pinguicula caerulea Walt.—*Manatee Co.:* in wet sandy pineland about 5 miles north of Parrish, *1054*, det. Barnhart.

Pinguicula lutea Walt.—*Lee Co.:* in moist sandy pineland, Coconut, *698*, det. Barnhart.

Pinguicula pumila Michx.—*Dade Co.:* in wet sandy soil, south of Florida City, *5847*. *Osceola Co.:* in moist sandy soil, west of Deer Park, *236*, det. Barnhart.

Pinguicula pumila var. *buswellii* Moldenke—*Collier Co.:* in moist sandy pineland along old Tamiami Trail, *981a*, type collection, originally distributed as *P. buswellii* Moldenke.

Setiscapella subulata (L.) Barnh.—*Orange Co.:* in moist sand of bog about 3 miles west of Bithlo, *209*, det. Barnhart.

Stomoisia cornuta (Michx.) Raf.—*Brevard Co.:* in shallow water along roadside about 8 miles west of Melbourne, *234a*, det. Barnhart. *Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3713*. *Monroe Co.:* in everglades near Pine Crest, *369*, det. Barnhart.

Utricularia foliosa L.—*Dade Co.:* in water of everglades along Tamiami Trail, 25 miles west of Miami, *3730*. *Monroe Co.:* floating in canal, Pine Crest, *653*, det. Barnhart.

Utricularia inflata Walt.—*Dade Co.:* in water of everglades, along Tamiami Trail, 25 miles west of Miami, *3729*.

Utricularia radiata Small—*Brevard Co.:* floating in water of ditch about 8 miles west of Melbourne, *230*, det. Barnhart.

Vesiculina purpurea (Walt.) Raf.—*Collier Co :* floating in canal along Tamiami Trail, *1007*, det. Barnhart.

BIGNONIACEAE

Anisostichus crucigera (L.) Bureau—*Dade Co.:* climbing over old wall, Buena Vista, Miami, *5552*, det. as *A. capreolata* (L.) Bur. by Killip.

Enallagma latifolia (Mill.) Small—*Dade Co.:* in dense hammock, Brickell Hammock, Miami, *721*.

Jacaranda ovalifolia R. Br.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5555*, originally distributed as "*J. ovatifolia* R. Br."

Kigelia pinnata (Jacq.) P. DC.—*Dade Co.:* in cultivation along roadside, Coral Gables, *3782*.

Parmentiera alata Miers—*Lee Co.:* in cultivation, Fort Myers, *5792*.

Pithecoctenium echinatum (Aubl.) K. Schum.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5725*.

Pyrostegia venusta (Ker) Baill.—*Dade Co.:* in cultivation, Miami, *3801*. *Highlands Co.:* in cultivation on fence along roadside, near Childs, *5415*.

Spathodea campanulata P. Beauv.—*Dade Co.:* in cultivation, Coconut Grove, *5686*.

Tecoma argentea Bureau & K. Schum.—*Dade Co.:* in cultivation, Coconut Grove, *5669*.

Tecoma stans A. L. Juss.—*Brevard Co.:* in cultivation, Eau Gallie, *5389*. *Monroe Co.:* in thickets, apparently escaped from cultivation, Key West, *803*.

Tecomaria capensis Seem.—*Dade Co.:* in cultivation, Miami, *3795*.

ACANTHACEAE

Asystasia coromandeliana Nees—*Dade Co.:* in cultivation, Coconut Grove, *5690*; in dry pineland, Buena Vista, Miami, *5706*. The species is not recorded in Small's Manual.

Blechum pyramidatum (Lam.) Urb.—*Lee Co.:* in dry soil along roadside, Fort Myers, *913*.

Diapedium assurgens (L.) Kuntze—*Monroe Co.:* in dry sandy soil along roadside, Lower Matecumbe Key, *620*.

Dyschoriste angusta (A. Gray) Small—*Collier Co.:* in dry sandy soil along edge of

Tamiami Trail, *659*. *Dade Co.*: in dry sandy soil among palmettos, Buena Vista, Miami, *273a*; in dry sandy waste soil, Buena Vista, Miami, *5496*.

Dyschoriste oblongifolia (Michx.) Kuntze—*Lee Co.*: in dry sandy pine woods, Fort Myers, *949*; in dry sandy pine woods south of Estero, *970*.

Elytraria angustifolia (Fernald) Leonard—*Dade Co.*: in moist sandy soil, south of Florida City, *746*, originally distributed as *Tubiflora angustifolia* (Fernald) Small.

Eranthemum nervosum R. Br.—*Dade Co.*: in cultivation, Miami, *3796*, det. Bailey, originally distributed as *Ruellia strepens* L.

Gerardia floridana (A. Gray) Small—*Dade Co.*: in dry sandy pineland, South Miami, *5825*.

Justicia crassifolia Chapm.—*Brevard Co.*: in sandy bog, near Melbourne, *5402*. *Gulf Co.*: in moist grassy field, north of Apalachicola, *1145*. Both these collections were originally distributed as *Dianthera crassifolia* Chapm.

Odontonema strictum (Nees) Kuntze—*Dade Co.*: in cultivation, Buena Vista, Miami, *5453*.

Ruellia ciliosa Pursh—*Hernando Co.*: in dry sandy woods, Brooksville, *5948*.

Ruellia hybrida Pursh—*Dade Co.*: in dry sandy soil among palmettos, Buena Vista, Miami, *426*. *Lee Co.*: in sandy pine woods on road to Coconut, *968*.

Ruellia parviflora (Nees) Britton—*Dade Co.*: in dry marl land, Homestead, *743a*; in sandy waste soil, Buena Vista, Miami, *5508*. *Seminole Co.*: in moist grassy clearing at edge of woods about 1½ miles south of Sanford, *184*.

Thunbergia erecta T. Anders.—*Dade Co.*: in cultivation, Buena Vista, Miami, *5710*.

Thunbergia erecta var. *alba* Hasselbring—*Dade Co.*: in cultivation, Buena Vista, Miami, *5711*, originally distributed as "*T. erecta* var. *alba* Hort."

Thunbergia fragrans Roxb.—*Dade Co.*: climbing over shrubs in Brickell Hammock, Miami, *489*; escaped from cultivation, Miami, *3643*.

Thunbergia grandiflora Roxb.—*Dade Co.*: in cultivation on arbor, Coconut Grove, *5619*. *Polk Co.*: in cultivation, Lake Wales, *5412*, det. Bailey, originally distributed as *Maurandia barclaiana* Lindl.

VERBENACEAE

Callicarpa americana L.—*Dade Co.*: in dry sandy waste soil, Buena Vista, Miami, *296*, *5476*; in everglades along Tamiami Trail, 25 miles west of Miami, *3728*.

Citharexylum fruticosum L.—*Dade Co.*: in swampy hammock, Miami, *3583*, originally distributed as *C. villosum* Jacq.; in Brickell Hammock, Miami, *5627*, *5637*.

Clerodendrum fragrans var. *pleniflorum* Schau.—*Dade Co.*: in dry sandy soil, apparently escaped from cultivation, Miami, *885*, extensively naturalized; in cultivation, Miami, *5826*. Both these collections were originally distributed as *Clerodendron fragrans* Vent.

Clerodendrum thomsonae Balf. f.—*Dade Co.*: in cultivation, Miami, *3642*, originally distributed as "*Clerodendron thompsonae* Balfour."

Duranta repens L.—*Dade Co.*: in cultivation, Miami, *3623*, originally distributed as *D. plumieri* Jacq.

Lantana camara var. *aculeata* (L.) Moldenke—*Dade Co.*: in cultivation and escaped at edge of hammock, Brickell Hammock, Miami, *5803*, originally distributed as *L. camara* L. *Lee Co.*: in dry sandy field, Fort Myers, *947*, originally distributed as *L. camara* var. *mutabilis* Bailey.

Lantana camara var. *mista* (L.) L. H. Bailey—*Monroe Co.*: in dry sandy soil, Key West, *797*, originally distributed as *L. camara* L.

Lantana citrosa (Small) Moldenke—*Dade Co.*: at edge of Caldwell Hammock, Silver Palm, *559*, originally distributed as *Goniostachyum citrosum* Small.

Lantana depressa Small—*Dade Co.*: decumbent in dry sandy soil, Cutler district, *735*.

Lantana involucrata L.—*Broward Co.:* in dry sandy soil, Lauderdale Beach, *259. Dade Co.:* in pineland, Miami, *3645. Monroe Co.:* in hammock, north end of Key Largo, *413.*

Lantana ovatifolia Britton—*Brevard Co.:* in dry sandy soil, Merritt's Island, *218. Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *307a;* in sandy soil along roadside, Miami, *3644.*

Phyla nodiflora (L.) Greene—*Brevard Co.:* in dry sandy soil near Melbourne, *5399. Dade Co.:* in dry sandy pineland and along roadsides, Buena Vista, Miami, *332, 5519;* in dry sandy waste patch, Miami, *3592. Duval Co.:* trailing in sand about 4 miles east of Eastport, *5281. Monroe Co.:* trailing in dry sandy soil, Key West, *787.* The first and fourth of these collections were originally distributed as *Lippia nodiflora* (L.) Michx.

Phyla nodiflora var. *reptans* (H.B.K.) Moldenke—*Monroe Co.:* in dry sandy soil, Lower Matecumbe Key, *5834,* originally distributed as *P. reptans* Greene.

Phyla sp.—*Duval Co.:* trailing in dry sand about 4 miles east of Eastport, *5282.*

Premna odorata Blanco—*Dade Co.:* in cultivation, Buena Vista, Miami, *5565,* originally distributed as *P. pubescens* Blume; Matheson Hammock, near Miami, *10375.*

Priva lappulacea (L.) Pers.—*Monroe Co.:* in dry sandy soil along roadside, Key Largo, *614,* originally distributed as *P. echinata* Juss.

Stachytarpheta jamaicensis (L.) Vahl—*Dade Co.:* in dry sandy soil along roadside, Buena Vista, Miami, *281;* in dry sandy soil, Redlands, *549a;* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3739.* These three collections were originally distributed as *Abena jamaicensis* (L.) A. S. Hitchc.

Stylodon carneus (Medic.) Moldenke—*Hernando Co.:* in moist grassy woods, Brooksville, *5946. Marion Co.:* in dry sandy woods, Irvine, *1091.* These collections were originally distributed as *Verbena carolinensis* (Walt.) J. F. Gmel.

Verbena maritima Small—*Brevard Co.:* in sand on coastal sand-dunes, Merritt's Island, *219a. Dade Co.:* in dry sandy soil, Redlands, *549;* in sand on coastal sand-dunes, Golden Beach, *586.*

Verbena scabra Vahl—*Broward Co.:* in moist sandy soil and wet ditch, Hollywood, *591, 599a. Lee Co.:* in moist sandy ditch, south of Estero, *972.*

Verbena tampensis Nash—*Orange Co.:* in dry sandy soil along roadside about 2 miles east of Fort Christmas, *212. Sarasota Co.:* in dry sandy soil, north of Venice, *1039.*

Verbena tenuisecta Briq.—*Jackson Co.:* in dry soil along fence, Marianna, *8354. Marion Co.:* in dry sandy soil along ditch, west of Flemington, *1083;* in dry sandy soil along roadside, east of Flemington, *1084a.* The two latter collections were originally distributed as *V. erinoides* Lam.

Verbena tenuisecta var. *alba* Moldenke—*Jackson Co.:* in dry sandy ditch, Sneads, *1163,* type collection, originally distributed as *V. erinoides* var. *alba* Hort.

AVICENNIACEAE

Avicennia nitida Jacq.—*Lee Co.:* in wet sandy soil at edge of mangrove swamp, Little Pine Island, *929. Monroe Co.:* in mangrove swamp, Key Largo, *5819.*

LAMIACEAE

Conradina canescens (T. & G.) A. Gray—*Franklin Co.:* in dry sandy soil, Carrabelle, *1133.*

Conradina grandiflora Small—*Dade Co.:* in dry sandy pineland, Opa-Locka, *448. Palm Beach Co.:* in dry sandy soil, Lake Worth City, *738.*

Hyptis pectinata (L.) Poir.—*Collier Co.:* in dry sandy soil along roadside, old Tamiami Trail, *5896. Dade Co.:* in dry sandy waste soil, Buena Vista, Miami, *484. Lee Co.:* in dry sandy soil, Fort Myers, *953a.*

Hyptis radiata Willd.—*Monroe Co.:* in dry sandy soil, Cypress Lodge, Pine Crest, *354.*

Leonotis nepetaefolia R. Br.—*Monroe Co.:* in dry sandy soil, Key West, *796.*

Mentha spicata L.—*Duval Co.:* in waste ground, South Jacksonville, *5252.*

Monarda punctata L.—*Duval Co.:* in moist ditch about 4 miles east of Eastport, *5268. Jackson Co.:* in moist ditch, Marianna, *8359. Lee Co.:* in dry open woods, Bonita Beach, *976a.*

Ocimum micranthum Willd.—*Monroe Co.:* in dry sandy soil, Cypress Lodge, Pine Crest, *353.*

Physostegia denticulata (Ait.) Britton—*Lee Co.:* in dry sandy pineland, Fort Myers, *690. Orange Co.:* in dry sandy soil along roadside about 4 miles north of Winter Park, *182.*

Pycnothymus rigidus (Bart.) Small—*Brevard Co.:* in dry sandy field about 2 miles west of Melbourne, *220. Dade Co.:* in dry sandy pineland, Opa-Locka, *447.*

Salvia azurea Lam.—*Jackson Co.:* in moist ditch, Marianna, *8357.*

Salvia coccinea L.—*Palm Beach Co.:* in sandy soil along roadside about 2 miles north of Canal Point, *251.*

Salvia lyrata L.—*Brevard Co.:* in dry sandy soil along roadside, Merritt's Island, *5387. Lee Co.:* in dry sandy soil, west of Fort Myers, *916.*

Salvia micrantha Vahl—*Dade Co.:* in sandy soil at edge of hammock, west of Fulford, *452,* det. Epling, originally distributed as *S. serotina* L.

Scutellaria arenicola Small—*Polk Co.:* in dry sandy soil about 2 miles south of Frostproof, *5413.*

Scutellaria floridana Chapm.—*Gulf Co.:* in dry sandy soil along roadside, north of Apalachicola, *1147.*

Scutellaria glabriuscula subsp. *laxa* Epl.—*Sarasota Co.:* in dry sandy soil along roadside, about 8 miles southeast of Venice, *1034,* det. Epling, originally distributed as *S. integrifolia* L.

Scutellaria integrifolia L.—*Duval Co.:* in waste ground, South Jacksonville, *5255,* det. Epling, originally distributed as *S. multiglandulosa* (Kearney) Small.

Scutellaria integrifolia subsp. *hispida* (Benth.) Epl.—*Leon Co.:* in dry waste ground, Tallahassee, *5978,* det. Epling, originally distributed and cited in my Annotated List (p. 111) as *S. integrifolia* L.

Scutellaria multiglandulosa (Kearney) Small—*Marion Co.:* in dry sandy woods, east of Flemington, *1088.*

Stachys floridana Shuttlw.—*Hendry Co.:* in moist sandy ditch, Labelle, *1031. Hernando Co.:* in moist sandy ditch, Brooksville, *1076.*

Teucrium nashii Kearney—*Palm Beach Co.:* in moist soil at edge of canal about 10 miles southeast of Canal Point, *254.*

Trichostema dichotomum L.—*Dade Co.:* in Arch Creek Hammock, *395. Lee Co.:* in dry sandy pineland, Salvista, *1075b.*

Trichostema suffruticosum Kearney—*Brevard Co.:* in moist sandy ditch, near Melbourne, *5400. Dade Co.:* in waste soil at edge of hammock along Tamiami Trail, 25 miles west of Miami, *3737.*

ALISMACEAE

Sagittaria angustifolia Lindl.—*Collier Co.:* in wet sandy ditch along roadside, south of Bonita Springs, *994.*

Sagittaria falcata Pursh—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3736.*

Sagittaria graminea Michx.—*Brevard Co.:* growing in shallow water of canal, with foliage submerged and only the scapes arising above the water, about 8 miles west of Melbourne, *229. Duval Co.:* in water of ditch, about 5 miles east of South Jacksonville, *5230.*

Sagittaria lancifolia L.—*Brevard Co.:* in water of ditch along roadside, near Melbourne, *5404. Broward Co.:* growing in about 2½ feet of water at edge of canal, west of Pompano, *469. Dade Co.:* in everglades along Tamiami Trail, 25 miles west of

Miami, *3735*. *Glades Co.:* in wet boggy ditch near Moore Haven, *1028*.

Sagittaria natans Michx.—*Clay Co.:* in wet ditch about 2 miles north of Orange Park, *5239*. *Leon Co.:* growing in about 4 feet of water in a pond, Tallahassee, *1167*.

POTAMOGETONACEAE

Potamogeton lucens L.—*Dade Co.:* growing in water of canal, completely submerged except for the flower-spikes, Royal Palm Park, *752*.

COMMELINACEAE[3]

Commelina angustifolia Michx.—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *381*. *Lee Co.:* in dry sandy soil along fence, East Fort Myers, *989*. *Polk Co.:* about 2 miles south of Frostproof, *239*.

Commelina erecta L.—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3757*.

Commelina gigas Small—*Lee Co.:* in dry sandy soil, Fort Myers, *5886*.

Commelina longicauda Jacq.—*Dade Co.:* in dry sandy waste soil, Buena Vista, Miami, *5527*. *Monroe Co.:* in dry sandy waste ground, Key West, *5837*.

Cuthbertia ornata Small—*Lee Co.:* in dry sandy pineland, Fort Myers, *899*, originally distributed as *C. rosea* (Vent.) Small, identified by Anderson & Woodson as *Tradescantia rosea* var. *ornata* (Small) Anderson & Woodson.

Cuthbertia rosea (Vent.) Small—*Lee Co.:* in dry sandy soil among palmettos, west of Fort Myers, *923*.

Rhoeo discolor (L'Hér.) Hance—*Dade Co.:* in cultivation, Miami, *3620;* in cultivation, Buena Vista, Miami, *5460*.

Tradescantia canaliculata Raf.—*Hernando Co.:* in dry sandy pine woods, Brooksville, *1078*, det. Anderson & Woodson. *St. Johns Co.:* in dry sandy field, St. Augustine, *166*, det. Anderson & Woodson. Both these collections were originally distributed as *T. reflexa* Raf.

Tradescantia dracaenoides Greenm.—*Dade Co.:* in cultivation, Buena Vista, Miami, *5849*.

Tradescantia hirsutiflora Bush—*Franklin Co.:* in sandy pine woods, East Point, *1135a*, det. Anderson & Woodson, originally distributed as *T. longifolia* Small.

Tradescantia longifolia Small—*Gulf Co.:* in dry sandy soil along roadside, Apalachicola, *1138*.

Tradescantia virginiana L.—*Franklin Co.:* in dry sandy woods, East Point, *5970*.

Zebrina pendula Schnitzl.—*Dade Co.:* in moist dark hammock, Comfort Canal region, Miami, *536*.

XYRIDACEAE

Xyris ambigua Beyr.—*Lee Co.:* in moist sandy pineland, Fort Myers, *686a;* in moist sandy pineland, south of Estero, *963*.

Xyris flabelliformis Chapm.—*Lee Co.:* in dry sandy pineland, Fort Myers, *687, 688a*.

Xyris flexuosa Muhl.—*Brevard Co.:* in sandy bog about 8 miles west of Melbourne, *224*. *Lee Co.:* in sandy pineland, Fort Myers, *686*.

ERIOCAULACEAE

Eriocaulon compressum Lam.—*Lee Co.:* in moist sandy pineland, Fort Myers, *689a*, originally distributed as *E. lineare* Small.

Eriocaulon compressum var. *harperi* Moldenke—*Lee Co.:* in dry sandy pineland, Fort Myers, *689*, originally distributed as *E. lineare* Small. *Wakulla Co.:* in wet sandy ditch, Medart, *1123*, originally distributed as *E. compressum* Lam.

Eriocaulon decangulare L.—*Brevard Co.:* in sandy bog about 8 miles west of Mel-

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3 On page 25 of my Annotated List no. *142a* is cited as from Florida and is identified as *Commelina nudiflora* L. This is an error, for the collection was made in South Carolina.

bourne, *233*. *Dade Co.*: in moist ditch, Buena Vista, Miami, *5591*. *Glades Co.*: at edge of canal near Citrus Center, *8396*.

Syngonanthus flavidulus (Michx.) Ruhl.—*Lee Co.*: in wet sandy pineland, Fort Myers, *688*; in wet sandy ditch, Big Pine Island, *940*.

BROMELIACEAE

Bromelia pinguin L.—*Dade Co.*: in cultivation, Buena Vista, Miami, *5850*.

Catopsis berteroniana (Schult.) Mez—*Dade Co.*: epiphytic on *Exothea paniculata*, Sykes Hammock, Redlands district, *556*.

Catopsis nutans (Sw.) Griseb.—*Dade Co.*: epiphytic on *Exothea paniculata*, Sykes Hammock, Redlands district, *557*.

Dendropogon usneoides (L.) Raf.—*Broward Co.*: epiphytic on *Quercus virginiana* branches, about 4 miles west of Davie, *5611*. *Dade Co.*: epiphytic on *Quercus virginiana*, Comfort Canal region, Miami, *538*; hanging from trees in hammock along Tamiami Trail, 25 miles west of Miami, *3756*.

Diaphoranthema recurvata (L.) Beer—*Dade Co.*: epiphytic on *Quercus virginiana*, Comfort Canal region, Miami, *535*. *Orange Co.*: epiphytic on *Quercus virginiana*, Orlando, *5329*.

Guzmannia monostachya (L.) Rusby—*Dade Co.*: on partly decayed fallen log, Sykes Hammock, Redlands district, *555*.

Tillandsia aloifolia Hook.—*Broward Co.*: epiphytic on *Taxodium distichum*, west of Pompano, *472*.

Tillandsia balbisiana Schult.—*Collier Co.*: epiphytic on *Taxodium distichum* in everglades along Tamiami Trail, *425*. *Dade Co.*: epiphytic on *Taxodium distichum* in everglades, Big Bend, on Tamiami Trail, *525a*.

Tillandsia circinata Schlecht.—*Broward Co.*: epiphytic on *Taxodium distichum*, west of Pompano, *486*.

Tillandsia fasciculata Sw.—*Collier Co.*: epiphytic on *Taxodium distichum* in everglades along Tamiami Trail, *424*. *Dade Co.*: epiphytic on tree at edge of hammock, Miami, *3621*.

Tillandsia polystachya L.—*Broward Co.*: epiphytic on *Taxodium distichum*, west of Pompano, *466*. *Monroe Co.*: epiphytic on *Taxodium distichum* in everglade hammock, Pine Crest, *656*.

Tillandsia sublaxa Baker—*Dade Co.*: epiphytic on *Quercus virginiana*, Lewis-Nixon Hammock, Redlands district, *554*.

Tillandsia tenuifolia L.—*Dade Co.*: epiphytic on *Ilex krugiana*, Hattie Bauer Hammock, Redlands district, *545*; on treetrunks in pineland hammock, Miami, *3791*.

Tillandsia utriculata L.—*Broward Co.*: epiphytic on *Quercus virginiana*, west of Pompano, *487*.

Tillandsia valenzuelana A. Rich.—*Dade Co.*: epiphytic on *Quercus virginiana*, Snapper Creek, *581*.

MUSACEAE

Musa sapientum L.—*Dade Co.*: in cultivation, Miami, *3799*.

CANNACEAE

Canna flaccida Roscoe—*Dade Co.*: in swamp, Miami, *333a*. *Monroe Co.*: in water of everglades near Pine Crest, *862*.

MARANTACEAE

Thalia divaricata Chapm.—*Collier Co.*: in water at edge of hammock along Tamiami Trail, *899a*. *Duval Co.*: in water of bog about 5 miles east of South Jacksonville, *5225*.

MELANTHIACEAE

Chrosperma muscaetoxicum (Walt.) Kuntze—*Calhoun Co.*: in moist sandy soil, south of Myron, *1156*.

Schoenocaulon dubium (Michx.) Small—*Hernando Co.*: in moist woods, Brooks-

ville, *5943*. *Marion Co.*: in dry sandy woods, east of Flemington, *1087*.

Tracyanthus angustifolius (Michx.) Small—*Wakulla Co.*: in moist sandy soil, south of Sopchoppy, *1129*.

CONVALLARIACEAE

Asparagus falcatus L.—*Dade Co.*: escaped from cultivation, Brickell Hammock, Miami, *5628*. The species is not recorded in Small's Manual.

Asparagus virgatus Baker—*Dade Co.*: in cultivation, Little River, *5730*.

PONTEDERIACEAE

Piaropus crassipes (Mart.) Britton—*Duval Co.*: washed ashore, about 4 miles east of Eastport, *5272*. *Glades Co.*: floating in water of canal, Moore Haven, *1030*.

Pontedaria cordata L.—*Dade Co.*: in water at edge of canal along Tamiami Trail, *844*.

Pontederia cordata var. *lancifolia* Morong—*Dade Co.*: in water of everglades along Tamiami Trail, 25 miles west of Miami, *3802*.

SMILACACEAE

Smilax auriculata Walt.—*Duval Co.*: trailing on sand along roadside, about 4 miles east of Eastport, *5288*.

Smilax beyrichii Kunth—*Dade Co.*: climbing up old *Citrus* tree, Buena Vista, Miami, *572*; in dry sandy waste field, Miami, *3685*; climbing over shrubs along roadside, Brickell Hammock, Miami, *5624*. *Volusia Co.*: in sand on dunes, Mosquito Inlet, *5303*.

Smilax bona-nox L.—*Dade Co.*: climbing over low shrubs along the old Cutler road, *732*; trailing in sandy waste soil, Miami, *3683*.

Smilax havanensis Jacq.—*Dade Co.*: in dry sandy soil, Miami, *3686*.

Smilax laurifolia L.—*Duval Co.*: climbing over low shrubs, about 5 miles east of South Jacksonville, *5228*. *Glades Co.*: climbing over shrubs at edge of woods, near Citrus Center, *8395*.

ARACEAE

Arisaema acuminatum Small—*Lee Co.*: in hammock, Bonita Beach, *5895*.

Monstera deliciosa Liebm.—*Dade Co.*: in cultivation, Miami, *3684*.

Peltandra virginica (L.) Kunth—*Dade Co.*: in moist soil at edge of canal, Big Bend, west of Tamiami Trail, *849*.

Pistia stratiotes L.—*Brevard Co.*: in water of canal, near Melbourne, *5401*.

TYPHACEAE

Typha angustifolia L.—*Collier Co.*: in everglades, Carnestown, *902*.

Typha latifolia L.—*Collier Co.*: in everglades, Carnestown, *903a*.

AMARYLLIDACEAE

Crinum americanum L.—*Monroe Co.*: in water of everglades, Pine Crest, *356*.

Hymenocallis caymanensis Herb.—*Monroe Co.*: along seashore, Key West, *5844*.

Hymenocallis tridentata Small—*Dade Co.*: in everglades, Big Bend, west of Tamiami Trail, *851*. *Glades Co.*: in boggy field, Citrus Center, *1022*.

Zephyranthes atamasco (L.) Herb.—*Dade Co.*: in everglades along Tamiami Trail, about 25 miles west of Miami, *3755*.

ALLIACEAE

Allium canadense L.—*Gulf Co.*: in moist ditch, Apalachicola, *1139*.

Allium mutabile Michx.—*Gadsden Co.*: in dry grassy swale, Chattahootchee, *1165*.

Nothoscordum bivalve (L.) Britton—*Lee Co.*: in dry sandy soil along roadside, Fort Myers, *691*, originally distributed as "*Nothoscordium bivalve* (L.) Britton."

IRIDACEAE

Iris savannorum Small—*Collier Co.*: in everglades south of Tamiami Trail, *870*.

Sisyrinchium atlanticum Bicknell—*Collier Co.*: in dry sandy soil along roadside,

Carnestown, *904*. *Dade Co.*: in moist sandy soil, South Miami, *446*; in dry sandy soil, Royal Palm Park, *753*. *Lee Co.*: in moist soil by brook, Coconut, *694*. *Monroe Co.*: in dry sandy soil along roadside, Pine Crest, *650*; in dry sandy pineland, Big Pine Key, *819a*.

Sisyrinchium fibrosum Bicknell—*Lee Co.*: in dry sandy soil among palmettos, Fort Myers, *955*.

Sisyrinchium floridanum Bicknell—*Dade Co.*: in dry sandy soil among palmettos, Buena Vista, Miami, *566*. *Manatee Co.*: in dry sandy soil, about 5 miles north of Parrish, *5921*.

Sisyrinchium fuscatum Bicknell—*Wakulla Co.*: in dry sandy field, south of Sopchoppy, *5966*.

Sisyrinchium graminoides Bicknell—*Dade Co.*: at edge of canal along Tamiami Trail, 25 miles west of Miami, *3803*.

Sisyrinchium xerophyllum Greene—*Dade Co.*: in dry sandy soil among palmettos of pineland, Buena Vista, Miami, *279*, *300a*, *5497*, *5593*; in dry sandy pineland, South Miami, *764*.

AGAVACEAE

Agave decipiens Baker—*Monroe Co.*: along roadside, Lower Matecumbe Key, *5833*.

Agave rigida Mill.—*Monroe Co.*: in sand, Boca Chica Key, *5846*.

Aletris bracteata Northrop—*Dade Co.*: in dry sandy marl, Seminole Plains, Black Point, *422*; in sandy soil near Royal Palm Park, *830*.

Aletris lutea Small—*Manatee Co.*: in moist sandy ditch, about 5 miles north of Parrish, *5922*. *Monroe Co.*: in dry sandy soil at edge of everglades, Pine Crest, *860*. *Wakulla Co.*: in moist sandy field, south of Sopchoppy, *1126*.

Aletris obovata Nash—*Gulf Co.*: in dry sandy pineland, Dalkeith, *1155*.

DRACAENACEAE

Yucca aloifolia L.—*Lee Co.*: in dry sand along Gulf coast, Bokeelia, *942*.

Yucca filamentosa L.—*Lake Co.*: in dry sandy soil at edge of woods, near Astatula, *5367*.

ARECACEAE

Arecastrum romanzoffianum Becc.—*Highlands Co.*: in cultivation along roadside, near Childs, *5416*.

Coccothrinax argentata (Jacq.) L. H. Bailey—*Dade Co.*: in sand on coastal sand-dunes, Miami Beach, *286*, det. Bailey, originally distributed as *C. argentea* (Lodd.) Sarg.

Cocos nucifera L.—*Dade Co.*: in cultivation, Miami, *3629*.

Paurotis wrightii (Griseb. & Wendl.) Britton—*Monroe Co.*: in everglades, Cape Sable region, *831*.

Phoenix canariensis Chaub.—*Lee Co.*: in cultivation, East Fort Myers, *5900*.

Phoenix dactylifera L.—*Dade Co.*: in cultivation, Buena Vista, Miami, *5452*.

Phoenix reclinata Jacq.—*Lee Co.*: in cultivation, East Fort Myers, *5901*.

Roystonea regia (H.B.K.) O. F. Cook—*Dade Co.*: in hammock, Royal Palm Park, *3710*.

Sabal etonia Swingle—*Dade Co.*: in dry sandy pineland, Buena Vista, Miami, *580*.

Sabal minor (Jacq.) Pers—*Dade Co.*: in waste ground and pinelands, Miami, *3628*, originally distributed as *S. adansonii* Guerns, *3689*, originally distributed as *S. glabra* (Mill.) Sarg.

Sabal palmetto (Walt.) Roem. & Schult.—*Brevard Co.*: in cultivation, Eau Gallie, *5390*. *Dade Co.*: in cultivation, Miami, *3580*.

Sabal sp.—*Dade Co.*: in hammock, Opa-Locka, *5752*.

Serenoa repens (Bartr.) Small—*Dade Co.*: in dry sandy pineland, Buena Vista, Miami, *318*, *327*, *331*; in waste ground of pineland, Miami, *3579*. All these collections

were originally distributed as *S. serrulata* (Michx.) Hook.

Serenoa sp. nov.—*Monroe Co.:* in hammock, Lower Matecumbe Key, *5739*, det. Bailey, originally distributed as *Thrinax floridana* Sarg.

Washingtonia filifera var. *robusta* Parish—*Dade Co.:* in cultivation along roadside, Little River, *5562*.

PANDANACEAE

Pandanus veitchii Dall.—*Dade Co.:* in cultivation, Miami, *3635*.

HAEMODORACEAE

Lachnanthes tinctoria (Walt.) Ell.—*Broward Co.:* in prairies about 4 miles west of Davie, *5610*, originally distributed as *Gyrotheca tinctoria* (Walt.) Salisb.

Lophiola americana (Pursh) Coville—*Wakulla Co.:* in moist sandy field, south of Sopchoppy, *1129a*.

HYPOXIDACEAE

Hypoxis juncea J. E. Sm.—*Lee Co.:* in moist sandy pine woods, west of Fort Myers, *924;* in moist sandy pine woods near Bonita Beach, *976;* in dry sandy pineland, Coconut, *5782*. *Volusia Co.:* in dry sandy soil, near Ariel, *5316*.

BURMANNIACEAE

Burmannia capitata (Walt.) Mart.—*Orange Co.:* in sandy bog about 3 miles west of Bithlo, *206*.

ORCHIDACEAE

Amphiglottis difformis (Jacq.) Britton—*Collier Co.:* epiphytic in hammock about 20 miles north of Big Bend on the Tamiami Trail, *5615*.

Anacheilium cochleatum (L.) Hoffmgg.—epiphytic on tree trunk, Royal Palm Park, *3711*. *Monroe Co.:* epiphytic on *Taxodium distichum* in wet hammock, Cape Sable region, *832a*.

Auliza nocturna (L.) Small—*Dade Co.:* epiphytic on *Ilex krugiana*, Hattie Bauer Hammock, Redlands district, *460*.

Bletia purpurea (Lam.) P. DC.—*Dade Co.:* in dry sandy marl, Seminole Plains, Black Point, *418;* in dry sandy marl along roadside, north of Goulds, *543a*.

Encyclia tampensis (Lindl.) Small—*Dade Co.:* epiphytic on *Quercus virginiana* in hammock, Little River, *438*.

Epicladium boothianum (Lindl.) Small—*Monroe Co.:* epiphytic on *Ichthyomethia piscipula* in hammock, Cape Sable region, *832b*.

Epidendrum anceps Jacq.—*Collier Co.:* epiphytic on *Fraxinus caroliniana* in wet hammock south of Tamiami Trail, *872;* epiphytic on *Taxodium distichum* in wet hammock south of Tamiami Trail, *879a*.

Habenella odontopetala (Reichenb. f.) Small—*Broward Co.:* in hammock, Long Island, west of Davie, *503*, *503a*.

Ibidium gracile (Bigel.) House—*Glades Co.:* in swampy ground, near Citrus Center, *8394*.

Ibidium longilabre (Lindl.) House—*Orange Co.:* in sandy bog about 3 miles west of Bithlo, *202*, det. as *Spiranthes longilabris* Lindl. by Ames, distributed originally as "*I. longilabris* (Lindl.) House." This is a rare species.

Ibidium odoratum (Nutt.) House—*Wakulla Co.:* along grassy fencerow, Wakulla, *5965*.

Ibidium praecox (Walt.) House—*Baker Co.:* in grassy bog, Glen St. Mary, *5985*. *Lee Co.:* in moist grassy ditch, Coconut, *5894*. *Manatee Co.:* in moist grassy field about 5 miles north of Parrish, *1048*. These three collections were identified as *Spiranthes praecox* (Walt.) S. Wats. by Ames.

Ibidium vernale (Engelm. & Gray) House—*Dade Co.:* in moist ditch, Seminole Plains, Black Point, *5542*. *Monroe Co.:* in moist sandy soil of everglades, Pine Crest, *5866*. Both these collections were determined as *Spiranthes vernalis* Engelm. & Gray by Ames.

Limodorum multiflorum (Lindl.) C. Mohr—*Lee Co.:* in dry sandy pine woods, Big Pine Island, *931*. This is a rare species.

Limodorum pallidum (Chapm.) C. Mohr—*Gulf Co.:* in wet sandy ditch, north of Apalachicola, *1144*.

Limodorum pinetorum Small—*Dade Co.:* in pineland near Miami, *10373*.

Limodorum simpsonii Small—*Baker Co.:* in grassy bog, Glen St. Mary, *5984*, det. Ames. *Collier Co.:* in everglades along Tamiami Trail, *898*. *Dade Co.:* in everglades south of Florida City, *824;* in everglades, Big Bend, west of Tamiami Trail, *851a*.

Limodorum tuberosum L.—*Franklin Co.:* in grassy bog, McIntyre, *1129b*.

Oncidium undulatum (Sw.) Salisb.—*Monroe Co.:* epiphytic on *Taxodium distichum* in hammock, Cape Cable region, *835a*.

Platypus alatus (L.) Small—*Broward Co.:* in prairies about 4 miles west of Davie, *5612*.

Pogonia ophioglossoides (L.) Ker—*Lee Co.:* in grassy bog, Coconut, *966*.

Spathiger rigidus (Jacq.) Small—*Dade Co.:* epiphytic on *Quercus virginiana*, Sykes Hammock, Redlands district, *571*.

Vanilla eggersii Rolfe—*Dade Co.:* in cultivation, Miami, *5873*.

Vanilla planifolia H. C. Andr.—*Dade Co.:* in cultivation, Miami, *5872*.

JUNCACEAE

Juncus biflorus Ell.—*Broward Co.:* in moist sandy ditch, west of Pompano, *5581*. *Lee Co.:* in sandy field, Bokeelia, *932*, originally distributed as *J. tenuis* Willd.

Juncus bliflorus var. *setosus* Coville—*Collier Co.:* in moist soil by canal south of Tamiami Trail, *5868*.

Juncus effusus L.—*Manatee Co.:* in marsh about 5 miles north of Parrish, *1047*.

Juncus polycephalus Michx.—*Collier Co.:* in everglades south of Tamiami Trail, *880*. *Monroe Co.:* in everglades along roadside, Pine Crest, *858*.

Juncus validus Coville—*Collier Co.:* in everglades at edge of hammock, south of Tamiami Trail, *873*, originally distributed as *J. polycephalus* Michx.

Juncus sp.—*Collier Co.:* in water of canal, Tamiami Trail, *5762*.

CYPERACEAE

Carex halei Torr.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3751*.

Carex longii Mackenzie—*Hernando Co.:* in moist sandy ditch along roadside, Brooksville, *1073*, det. Mackenzie.

Carex lupulina Muhl.—*Collier Co.:* in moist soil at edge of canal, Turner's River Hammock, *666*, det. Mackenzie.

Carex uberior (C. Mohr) Mackenzie—*Alachua Co.:* in moist grassy ditch, north of Micanopy, *1093*, det. Mackenzie.

Carex sp.—*Collier Co.:* in moist rich soil, Turner's River Hammock, *5764*.

Cyperus alternifolius L.—*Dade Co.:* growing partly in the water at edge of canal, Little River, *610*, det. Britton.

Cyperus brunneus Sw.—*Dade Co.:* in sand on coastal sand-dunes, Miami Beach, *386*, det. Britton, *578*, det. Britton. *Monroe Co.* in dry sandy soil along roadside, Plantation Key, *635*, det. Britton, *636*, det. Britton.

Cyperus compressus L.—*Duval Co.:* in moist ditch about 5 miles east of South Jacksonville, *5221*, det. Britton.

Cyperus distinctus Steud.—*Broward Co.:* in moist soil at edge of canal, west of Pompano, *457*, det. O'Neill. *Duval Co.:* in bog near river, South Jacksonville, *5254*, det. O'Neill. *Lee Co.:* in wet field along edge of hammock, south of Fort Myers, *651*, det. O'Neill. The first and third of these collections were determined by Britton as *C. virens* Michx., and so distributed, while the second was determined by him as *C. pseudovegetus* Steud. and so distributed.

Cyperus elegans L.—*Monroe Co.:* in dry sandy soil, Lower Matecumbe Key, *631*, det. Britton.

Cyperus esculentus L.—*Dade Co.:* in dry sandy soil along roadside, Little River, *527a*, det. Britton.

Cyperus ferax L. C. Rich.—*Broward Co.:* in sandy soil at edge of marsh, Hollywood, *598a*, det. Britton. *Dade Co.:* in sandy soil at edge of Brickell Hammock, Miami, *724*, det. Britton.

Cyperus filicinus Vahl—*Duval Co.:* in moist sandy ditch about 4 miles east of Eastport, *5270*, det. Britton.

Cyperus globulosus Aubl.—*Broward Co.:* in sandy soil along roadside, Hollywood, *588a*, det. Britton. *Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *317*, det. Britton; in dry sandy soil, Little River, *527*, det. Britton. *Sarasota Co.:* in dry sandy soil along roadside, north of Venice, *1043*, det. Britton.

Cyperus grayii Torr.—*Clay Co.:* in moist ditch about 2 miles north of Orange Park, *5237*.

Cyperus haspan L.—*Broward Co.:* in moist rich soil of hammock, west of Pompano, *458*, det. Britton. *Monroe Co.:* in water of everglades, Pine Crest, *676*, det. Britton.

Cyperus lecontei Torr.—*Franklin Co.:* in dry sandy soil near Gulf, Carrabelle, *1132*, det. Britton.

Cyperus ligularis L.—*Broward Co.:* in sandy soil at edge of marsh, Hollywood, *598*, det. Britton. *Collier Co.:* in moist sandy soil at edge of canal, Carnestown, *905*, det. Britton. *Dade Co.:* in dry sandy soil along edge of canal near Bay Biscayne, Buena Vista, Miami, *297*, det. Britton; in everglades, Miami, *10387*, cited on page 22 of my Annotated List and distributed as *C. halei* Torr.; in dry sandy pineland, Buena Vista, Miami, *5468*, det. Britton. *Monroe Co.:* in dry sandy soil along roadside, Lower Matecumbe Key, *632*, det. Britton.

Cyperus martindalei Britton—*Dade Co.:* in dry sandy pineland among palmettos, Buena Vista, Miami, *880a*, det. Britton, *5863*, det. Britton.

Cyperus microdontus Torr.—*Broward Co.:* in sandy soil along roadside, Hollywood, *588*, det. Britton.

Cyperus odoratus L.—*Broward Co.:* in sandy soil near coast, Hollywood, *582*, det. O'Neill. *Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3752*, det. O'Neill. *Duval Co.:* in moist ditch about 5 miles east of South Jacksonville, *5222*, det. O'Neill. *Monroe Co.:* in everglades near Pine Crest, *863*, det. O'Neill. Number 5222 was determined by Britton as *C. haspan* L., so distributed, and so cited on page 22 of my Annotated List; all the rest of the collections were identified by Britton as *C. ferax* L. C. Rich. and so distributed.

Cyperus polystachyos var. *leptostachyus* Boeckl.—*Collier Co.:* in water by canal, south of Tamiami Trail, *5870*, det. O'Neill. *Dade Co.:* in rich soil of Opa-Locka Hammock, *494*, det. O'Neill. *Monroe Co.:* in dry sandy field, Key West, *798*, det. O'Neill. *Sarasota Co.:* in dry sandy soil along roadside, north of Venice, *1042*, det. O'Neill. The first of these collections was identified by Britton as *C. paniculatus* Rottb. and so distributed; all the rest were determined by him as *C. microdontus* Torr. and so distributed.

Cyperus rotundus L.—*Dade Co.:* in dry sandy soil along roadside near Brickell Hammock, Miami, *603*, det. Britton.

Cyperus sp.—*Collier Co.:* in rich soil of clearing, Turner's River Hammock, *5769*. *Lee Co.:* in wet sandy ditch, Fort Myers, *5774*.

Dichromena colorata (L.) A. S. Hitchc.—*Brevard Co.:* in moist sandy ditch, near Melbourne, *5392*, det. Britton. *Dade Co.:* in wet ditch, Buena Vista, Miami, *5798*. *Lee Co.:* in moist ditch along roadside, west of Fort Myers, *918*, det. Britton. *Monroe Co.:* in everglades, Pine Crest, *359*, det. Britton.

Dichromena latifolia Baldw.—*Dade Co.* in everglades along Tamiami Trail, 25 miles west of Miami, *3808*. *Glades Co.:* in swampy ground near Citrus Center, *8392*. *Gulf Co.:* in sandy field, south of Dalkeith, *1150*, det. Britton.

Dichromena sp.—*Dade Co.:* in wet ditch, Buena Vista, Miami, *5812*.

Eleocharis baldwinii (Torr.) Chapm.—*St. Johns Co.:* in moist sandy soil near Orange Dale, *5245*, det. Britton.

Eleocharis caribaea (Rottb.) Blake—*Collier Co.:* in dry sandy waste soil, about 20 miles north of Big Bend along the Tamiami Trail, *511*, det. Britton.

Eleocharis interstincta (Vahl) R. & S.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3807*.

Fimbristylis autumnalis (L.) R. & S.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3806*. *Osceola Co.:* in wet sandy soil, east of Kissimmee, *5410*, det. Britton.

Fimbristylis castanea (Michx.) Vahl—*Duval Co.:* in waste ground about 4 miles east of Eastport, *5276*, det. Britton. *Monroe Co.:* in dry sandy soil along roadside, Summerland Key, *786*, det. Britton. *Orange Co.:* in sandy bog about 2 miles east of Fort Christmas, *5386*, det. Britton.

Fimbristylis sp.—*Dade Co.:* in sandy pineland, Buena Vista, Miami, *5795*.

Fuirena breviseta Coville—*Duval Co.:* in moist sandy ditch about 5 miles east of Jacksonville, *167b*, det. Britton. *Monroe Co.:* in everglades at edge of canal, Pine Crest, *373*, det. Britton.

Fuirena hispida Ell.—*Okeechobee Co.:* in moist ditch, Okeechobee City, *244*, det. Britton.

Fuirena scirpoidea Michx.—*Lee Co.:* in moist ditch along roadside, south of Fort Myers, *662*, det. Britton.

Kyllingia brevifolia Rottb.—*Manatee Co.:* in sandy ditch about 5 miles north of Parrish, *1049*, det. Britton.

Kyllingia odorata Vahl—*Alachua Co.:* in dry sandy ditch, Gainesville, *5953*, det. Britton.

Mariscus jamaicensis (Crantz) Britton—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3804*. *Monroe Co.:* in everglades, Cape Sable region, *837*, det. Britton.

Psilocarya nitens (Vahl) A. Wood—*Broward Co.:* in dry soil along roadside west of Pompano, *459*, det. Britton.

Rynchospora axillaris (Lam.) Britton—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3805*.

Rynchospora caduca Ell.—*Monroe Co.:* growing in shallow water of everglades, Pine Crest, *655*, det. Britton.

Rynchospora careyana Fernald—*Broward Co.:* in wet sandy ditch, west of Pompano, *5578*, det. Britton.

Rynchospora chapmanii M. A. Curtis—*Lee Co.:* in dry sandy ditch, south of Estero, *5890*, det. Britton.

Rynchospora ciliaris (Michx.) C. Mohr—*Orange Co.:* in sandy field about 3 miles west of Bithlo, *201*, det. Britton.

Rynchospora corniculata (Lam.) A. Gray—*Monroe Co.:* in everglades at edge of hammock, Pine Crest, *857*, det. Britton.

Rynchospora cymosa Ell.—*Lee Co.:* in moist sandy ditch along roadside, Rialto, *1011*, det. Britton, *5906*, det. Britton; in sandy bog, Coconut, *5788*, det. Britton.

Rynchospora divergens M. A. Curtis—*Lee Co.:* in dry sandy field near municipal airport, Fort Myers, *684*, det. Britton; in wet sandy ditch, Rialto, *5907*, det. Britton.

Rynchospora dodecandra Baldw.—*Dade Co.:* in dry sandy soil in *Ceratiola* association, Miami, *883*, det. Britton.

Rynchospora fascicularis (Michx.) Vahl—*Sarasota Co.:* in dry sandy soil about 8 miles southeast of Venice, *1035*, det. Britton, who says it is a "rare form."

Rynchospora grayi Kunth—*Dade Co.:* in dry sandy soil among palmettos, Buena Vista, Miami, *607*, det. Britton.

Rynchospora miliacea (Lam.) A. Gray—*Hernando Co.:* in moist woodland, south of Aripeka, *1065*, det. Britton.

Rynchospora perplexa Britton—*Collier Co.:* in everglades, south of Tamiami Trail, *879*, det. Britton.

Rynchospora plumosa Ell.—*Lee Co.:* in moist sandy soil at edge of ditch, Fort Myers, *675*, det. Britton. *Manatee Co.:* in dry sandy soil about 5 miles north of Parrish, *1052*, det. Britton.

Rynchospora rariflora (Michx.) Ell.—*Manatee Co.:* in moist ditch along roadside about 5 miles north of Parrish, *1053*, det. Britton.

Rynchospora sp.—*Duval Co.:* in dry sandy soil along roadside, about 5 miles east of Jacksonville, *6536*. *Lee Co.:* in dry sandy pineland, Fort Myers, *692a*.

Schoenus nigricans L.—*Dade Co.:* in everglades along edge of canal, Florida City, *611*, det. Britton.

Scirpus lineatus Michx.—*Duval Co.:* in moist ditch about 5 miles east of Jacksonville, *6535*, det. Britton, who says this is the first record of the species from Florida.

Scirpus validus Vahl—*Sarasota Co.:* in marshy bog north of Venice, *1041*.

Scleria ciliata Michx.—*Collier Co.:* in shallow water, Turner's River Hammock, *5766*, det. Britton. *Manatee Co.:* in dry sandy field about 5 miles north of Parrish, *1050a*, det. Britton.

Scleria triglomerata Michx.—*Dade Co.:* in moist hammock, Arch Creek, *894*, det. Britton. *Franklin Co.:* in sandy pine woods, East Point, *1135*, det. Britton.

POACEAE

Agrostis hyemalis (Walt.) B. S. P.—*Alachua Co.:* in moist ditch north of Micanopy, *1092*, det. Hitchcock.

Agrostis sp.—*Orange Co.:* in waste soil, Orlando, *5375*.

Andropogon brachystachys Chapm.—*St. Johns Co.:* in dry sandy soil along roadside, near Sampson, *5291*, det. Hitchcock.

Andropogon gracilis Spreng.—*Dade Co.:* in sandy marl among palmettos, Buena Vista, Miami, *895*, det. Hitchcock; in dry sandy pineland, Buena Vista, Miami, *5545*, collected by Mrs. E. O. Groves, det. Hitchcock.

Andropogon hirtiflorus (Nees) Kunth—*Dade Co.:* in sandy soil along roadside, Buena Vista, Miami, *434*, det. Hitchcock,

Andropogon longiberbis Hack.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5544*, collected by Mrs. E. O. Groves, det. Hitchcock.

Aristida spiciformis Ell.—*Clay Co.:* in dry sandy soil about 2 miles north of Orange Park, *5242*, det. Hitchcock.

Arundinaria japonica Sieb. & Zucc.—*Dade Co.:* in swampy ground, escaped from cultivation, Miami, *3633*. This species is not recorded in Small's Manual.

Avena sativa L.—*Collier Co.:* in dry sandy soil along roadside, south of Bonita Springs, *995*, det. Hitchcock.

Bromus secalinus L.—*Leon Co.:* in dry sandy soil along roadsides, Tallahassee, *5959*.

Bromus unioloides H.B.K.—*Leon Co.:* in dry sandy soil along roadsides, Tallahassee, *1131*, det. Hitchcock.

Capriola dactylon (L.) Kuntze—*Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3809*. *Lee Co.:* in dry sandy orchard, Fort Myers, *679*, det. Hitchcock.

Cenchrus carolinianus Walt.—*Dade Co.:* in waste ground, Miami, *3634*.

Cenchrus echinatus L.—*Dade Co.:* in dry sandy pineland and waste soil along roadside, Buena Vista, Miami, *525*, det. Hitchcock, *718*, det. Hitchcock, *5485*, det. Hitchcock.

Cenchrus gracillimus Nash—*Dade Co.:* in dry sandy soil along roadside, Rockdale, *563*, det. Hitchcock; in dry sandy pineland, Buena Vista, Miami, *719*, det. Hitchcock, *5564*, det. Hitchcock. *Orange Co.:* in dry sandy soil along roadside about 3 miles north of Winter Park, *5341*, det. Hitchcock.

Cenchrus pauciflorus Benth.—*Dade Co.:* in sandy soil along roadside, Little River, *529*, det. Hitchcock. *Monroe Co.:* in dry sandy soil along roadside, Lower Matecumbe Key, *760*, det. Hitchcock.

Cenchrus viridis Spreng.—*Monroe Co.:* in dry sandy soil at edge of hammock, Key Largo, *781*, det. Hitchcock.

Chaetochloa corrugata (Ell.) Scribn.—*Dade Co.:* in rich soil along edge of hammock, Opa-Locka Hammock, *495*, det. Hitchcock.

Chaetochloa geniculata (Lam.) Millsp. & Chase—*Collier Co.:* in moist sandy clearing, Turner's River Hammock, *672*, det. Hitchcock. *Dade Co.:* at edge of Opa-Locka Hammock, *5598*.

Chaetochloa macrosperma Scribn. & Merr.—*Monroe Co.:* along roadside, Cape Sable region, *5860*, det. Hitchcock.

Chaetochloa magna (Griseb.) Scribn.—*Martin Co.:* in dry sandy soil along roadside about 1 mile north of Fort Mayaca, *5438*, det. Hitchcock. *Monroe Co.:* in sandy soil along edge of canal, Key Largo, *414*, det. Hitchcock.

Chaetochloa palmifolia (Willd.) Hitchc. & Chase—*Dade Co.:* in cultivation, Buena Vista, Miami, *5715*, originally distributed as *Panicum plicatum* Lam. and later corrected to *Setaria palmifolia* (Willd.) Stapf.

Chloris glauca (Chapm.) Vasey—*Dade Co.:* along edge of canal along Tamiami Trail, 25 miles west of Miami, *3741*, det. Hitchcock. *Palm Beach Co.:* in sandy soil along edge of canal about 10 miles southeast of Canal Point, *253*, det. Hitchcock.

Chloris polydactyla (L.) Sw.—*Monroe Co.:* in sand along roadside at border of mangrove swamp, Key Largo, *403*, det. Hitchcock.

Coelorachis rugosa (Nutt.) Nash.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3742*, det. Hitchcock. *Monroe Co.:* in dry sandy soil, Pine Crest, *5866a*, det. Hitchcock.

Dactyloctenium aegypticum (L.) Willd.—*Dade Co.:* in dry sandy soil, Miami, *3800*.

Digitaria sanguinalis (L.) Scop.—*Broward Co.:* in dry soil at edge of small hammock, west of Hollywood, *497*. *Duval Co.:* in sandy waste ground about 4 miles east of Eastport, *5277*. Both these collections were originally identified by Hitchcock and distributed as *Syntherisma sanguinalis* (L.) Dulac.

Echinochloa crusgalli (L.) P. Beauv.—*Broward Co.:* in sand along roadside, Hollywood, *593*, det. Hitchcock. *Monroe Co.:* in dry sandy soil, Pine Crest, *6698*, det. Hitchcock.

Echinochloa paludigena Wieg.—*Broward Co.:* in moist rich soil of cultivated field, west of Pompano, *476*, det. Hitchcock.

Echinochloa pungens (Poir.) Rydb.—*Broward Co.:* in sandy soil along roadside, west of Pompano, *546a*, det. Gleason, originally identified by Hitchcock and distributed as "*E. crusgalli* (L.) Beauv."

Echinochloa walteri (Pursh) Heller—*Broward Co.:* in sandy soil along canal embankment, north of Davie, *509*, det. Hitchcock. *Highlands Co.:* in rich soil along roadside, near Childs, *241*, det. Hitchcock.

Eleusine indica (L.) Gaertn.—*Duval Co.:* in waste ground, South Jacksonville, *5259*, det. Hitchcock.

Eragrostis amabilis (L.) Wight & Arn.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5568*, det. Hitchcock. *Monroe Co.:* in dry sandy soil along roadside, Key Largo, *615*, det. Hitchcock.

Eragrostis ciliaris (L.) Link—*Dade Co.:* in sandy pineland among palmettos, Buena Vista, Miami, *444*, det. Hitchcock; at edge of road along Tamiami Trail, 25 miles west of Miami, *3738;* in dry sandy pineland, Buena Vista, Miami, *5546*, collected by Mrs. E. O. Groves, det. Hitchcock.

Eragrostis elliottii S. Wats.—*Orange Co.:* in dry sandy soil along roadside, south of Wekiva Springs, *5358*, det. Hitchcock.

Erianthus saccharoides Michx.—*Broward Co.:* west of Davie, *506*, det. Hitchcock. *Dade Co.:* at outskirts of Miami, *3794*, det. Hitchcock.

Eustachys petraea (Sw.) Desv.—*Dade Co.:* at edge of Tamiami Trail, 25 miles west of Miami, *3740*, det. Hitchcock.

Festuca octoflora Walt.—*Suwannee Co.:* in dry sandy soil along roadside, Houseton, *5958*, det. Hitchcock.

Holcus halapensis L.—*Dade Co.:* in sandy soil along roadside near Brickell Hammock, Miami, *522*, det. Hitchcock; in sandy soil along roadside, Buena Vista, Miami, *704*, det. Hitchcock.

Holcus sorghum L.—*Dade Co.:* in dry sandy soil along roadside, west of Fulford, *5569*, det. Hitchcock.

Hyparrhenia rufa (Nees) Stapf—*Okeechobee Co.:* in waste soil, Okeechobee City, *243*, det. Hitchcock.

Imperata brasiliensis Trin.—*Dade Co.:* in dry rocky marl, Homestead, *743*, det. Hitchcock; along roadside, Brickell Hammock, Miami, *5698*, det. Hitchcock.

Lasiacis divaricata (L.) A. S. Hitchc.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3747*, det. Hitchcock. *Monroe Co.:* in dense tropical hammock, north end of Key Largo, *407*, det. Hitchcock.

Leptochloa dubia (H.B.K.) Nees—*Collier Co.:* in sand on sand-dunes, Caxambas, *999*, det. Hitchcock.

Leptochloa filiformis (Lam.) P. Beauv.—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3746*, det. Hitchcock.

Leptochloa virgata (L.) P. Beauv.—*Dade Co.:* in dry sandy soil along roadside, Seminole Plains, Black Point, *5543*, det. Hitchcock.

Lolium multiflorum Lam.—*Leon Co.:* in dry sandy soil along roadside, Tallahassee, *1171*, det. Hitchcock.

Melinis minutiflora P. Beauv.—*Dade Co.:* in sandy soil among palmettos, west of Fulford, *453*, Hitchcock. *Okeechobee Co.:* along roadside, Okeechobee City, *5421*, det. Hitchcock.

Monanthochloë littoralis Engelm.—*Monroe Co.:* in moist sand at edge of water, Boca Chica Key, *809*, det. Hitchcock.

Neyraudia arundinacea (L.) Henr.—*Dade Co.:* in marshy soil along edge of mangrove swamp, near Bay Biscayne, Buena Vista, Miami, *432*, det. Hitchcock; in dry sandy soil, Buena Vista, Miami, *432a*, det. Hitchcock.

Oplismenus setarius (Lam.) Roem. & Schult.—*Broward Co.:* on floor of hammock, Long Island, west of Davie, *5608*, det. Hitchcock.

Panicum adspersum Trin.—*Dade Co.:* in sandy soil along roadside, Little River, *533*, det. Hitchcock. *Monroe Co.:* in sandy soil along edge of hammock, Lower Matecumbe Key, *633*, det. Hitchcock; in dry grassy field, Key West, *788*, det. Hitchcock.

Panicum agrostoides Spreng.—*Duval Co.:* in dry sandy soil about 5 miles east of South Jacksonville, *5223*, det. Hitchcock.

Panicum albomarginatum Nash—*Lee Co.:* in dry sandy field near municipal airport, Fort Myers, *693a*, det. Hitchcock.

Panicum barbinode Trin.—*Broward Co.:* in dry sandy field, Hollywood, *589*, det. Hitchcock. *Palm Beach Co.:* in dry sandy soil along roadside about 10 miles south of Canal Point, *5443*, det. Hitchcock.

Panicum bartowense Scribn. & Merr.—*Broward Co.:* in prairies along the Pine Island road, west of Davie, *500*, det. Hitchcock. *Monroe Co.:* in sandy soil along edge of canal, Key Largo, *406*, det. Hitchcock; in sand at edge of mangrove swamp, Boca Chica Key, *812*, det. Hitchcock; along roadside, Cape Sable region, *5859*, det. Hitchcock.

Panicum condensatum Nash—*Broward Co.:* growing in 2 feet of water in canal, west of Pompano, *473*, det. Hitchcock. *Dade Co.:* at edge of canal along Tamiami Trail, 25 miles west of Miami, *3748*, det. Hitchcock.

Panicum dichotomiflorum Michx.—*Duval Co.:* in sandy waste soil about 4 miles east of Eastport, *5271*, det. Hitchcock. *Okeechobee Co.:* in dry soil along roadside, Okeechobee City, *5422*, det. Hitchcock.

Panicum erectifolium Nash—*Collier Co.:* in moist sandy pineland, East Naples, *908*, det. Hitchcock.

Panicum fasciculatum Sw.—*Collier Co.:* in moist sandy clearing, Turner's River Hammock, *670*, det. Hitchcock.

Panicum fusiforme A. S. Hitchc.—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *5590*, det. Hitchcock, *5856*, det. Hitchcock.

Panicum glabrifolium Nash—*Lee Co.:* in open sandy pine woods, Big Pine Island, *939*, det. Hitchcock.

Panicum hemitomon Schult.—*Dade Co.:* growing in about 2½ feet of water in canal at edge of Tamiami Trail, *845*, det. Hitchcock. *Monroe Co.:* growing in about a foot of water in everglades, Pine Crest, *867*, det. Hitchcock.

Panicum hians Ell.—*Collier Co.:* in clearing, Turner's River Hammock, *5768*, det. Hitchcock. *Lee Co.:* in moist ditch along roadside, Big Pine Island, *943*, det. Hitchcock.

Panicum joorii Vasey—*Collier Co.:* in moist sandy clearing, Turner's River Hammock, *665*, det. Hitchcock. *Dade Co.:* in rich soil along edge of Opa-Locka Hammock, *492*, det. Hitchcock.

Panicum laxiflorum Lam.—*Broward Co.:* in dense tropical hammock, Long Island, west of Davie, *501*, det. Hitchcock.

Panicum maximum Jacq.—*Dade Co.:* in waste ground, Miami, *3671;* in dry sandy soil along roadside, Brickell Hammock, Miami, *5631*, det. Hitchcock.

Panicum patentifolium Nash—*Clay Co.:* in sandy waste ground about 2 miles north of Orange Park, *5240*, det. Hitchcock.

Panicum polycaulon Nash—*Lee Co.:* in dry sandy field near airport, Fort Myers, *693*, det. Hitchcock.

Panicum virgatum L.—*Dade Co.:* in open sandy clearing at edge of mangrove swamp near Bay Biscayne, Buena Vista, Miami, *574*, det. Hitchcock; in moist ditch along roadside, Buena Vista, Miami, *5592*, det. Hitchcock; in dry sandy soil, west of Hollywood, *5599*. *Franklin Co.:* in dry sandy waste ground, Apalachicola, *5589*, collected by C. A. Mosier, det. Hitchcock.

Paspalum blodgettii Chapm.—*Monroe Co.:* in sand along roadside, Key Largo, *405*, det. Hitchcock; in moist sandy soil at edge of mangrove swamp, Summerland Key, *785*, det. Hitchcock.

Paspalum caespitosum Flügge—*Dade Co.:* at edge of Tamiami Trail, 25 miles west of Miami, *3745*, det. Hitchcock.

Paspalum ciliatifolium Michx.—*Dade Co.:* in sandy soil along roadside, Little River, *532*, det. Hitchcock.

Paspalum dilatatum Poir.—*Leon Co.:* in dry sandy soil at edge of small pond, Tallahassee, *1120*, det. Hitchcock.

Paspalum floridanum Michx.—*Dade Co.:* in waste ground, Miami, *3793*, det. Hitchcock.

Paspalum longipedunculatum Le Conte—*Dade Co.:* in dry sandy pineland, Buena Vista, Miami, *759a*, det. Hitchcock, *5705a*, det. Hitchcock.

Paspalum plicatulum Michx.—*Alachua Co.:* in dry sandy soil along roadside, Gainesville, *1096*, det. Hitchcock.

Paspalum praecox Walt.—*Osceola Co.:* in boggy ground, east of Kissimmee, *5411*, det. Hitchcock.

Paspalum rigidifolium Nash—*Dade Co.:* in dry sandy pineland among palmettos, Buena Vista, Miami, *606a*, det. Hitchcock, *5705b*, det. Hitchcock.

Paspalum urvillei Steud.—*Broward Co.:* in dry sandy field, Hollywood, *590*, det. Hitchcock. *Manatee Co.:* in moist ditch, Ellenton, *1046*, det. Hitchcock.

Paspalum vaginatum Sw.—*Duval Co.:* in dry sandy soil about 4 miles east of Eastport, *5269*, det. Hitchcock.

Pennisetum purpureum Schum.—*Dade Co.:* in sandy pineland near Opa-Locka, *496*, det. Hitchcock. *Lake Co.:* in sandy open woods, north of Mineola, *5372*, det. Hitchcock. *Palm Beach Co.:* in dry sandy soil along roadside, South Bay, *738b*, det. Hitchcock.

Phragmites communis var. *berlandieri* (Fourn.) Fernald—*Martin Co.:* in swampy soil about 1 mile north of Fort Mayaca, *5437*, det. as *P. communis* Trin. by Hitchcock and so distributed.

Sacciolepis striata (L.) Nash—*Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3744*, det. Hitchcock.

Spartina alterniflora var. *glabra* (Muhl.) Fernald—*Duval Co.:* in sandy waste ground about 4 miles east of Eastport, *5278*, det. Hitchcock.

Sphenopholis obtusata (Michx.) Scribn.—*Gulf Co.:* in dry sandy clearing, Apalachicola, *1136*, det. Hitchcock.

Sporobolus domingensis (Trin.) Kunth—*Monroe Co.:* in dry sandy soil along roadside, north end of Key Largo, *415*, det. Hitchcock, *616*, det. Hitchcock.

Sporobolus gracilis (Trin.) Merr.—*Dade Co.:* in sandy marl among palmettos, Buena Vista, Miami, *482*, det. Hitchcock; in sandy marl, Rockdale, *560*, det. Hitchcock.

Sporobolus virginicus (L.) Kunth—*Lee Co.:* in sand along edge of Gulf of Mexico, Bokeelia, *936*, det. Hitchcock.

Stenotaphrum secundatum (Walt.) Kuntze—*Dade Co.:* in sand on dunes, Golden Beach, *585*, det. Hitchcock; in waste ground along roadside, Buena Vista, Miami, *5504*, det. Hitchcock.

Thysanolaena maxima (Roxb.) Kuntze—*Dade Co.:* in cultivation, Coconut Grove, *5689*, det. Hitchcock.

Tricholaena rosea Nees—*Dade Co.:* in sandy field near Brickell Hammock, Miami, *521*, det. Hitchcock; in waste sandy soil along roadside, Miami, *3695*.

Triodia flava (L.) Smyth—*Broward Co.:* in dry soil along roadside, west of Hollywood, *498*, det. Hitchcock.

Tripsacum dactyloides L.—*Broward Co.:* in dry sandy field, Hollywood, *583*, det. Hitchcock. *Dade Co.:* in everglades along Tamiami Trail, 25 miles west of Miami, *3743*, det. Hitchcock.

Uniola paniculata L.—*Broward Co.:* in sand on dunes, Lauderdale Beach, *255*, det. Hitchcock. *Volusia Co.:* in sand on dunes, Mosquito Inlet, *5299*, det. Hitchcock.

Valota insularis (L.) Chase—*Dade Co.:* in sandy soil along roadside, near Brickell Hammock, Miami, *522a*, det. Hitchcock. *Monroe Co.:* in sand along roadside, Key Largo, *416*, det. Hitchcock; in dry sandy field, Lower Matecumbe Key, *634*, det. Hitchcock.

Zizaniopsis miliacea (Michx.) Doell. & Aschers.—*Broward Co.:* in sandy soil along embankment about 4 miles west of Davie, *510*, det. Hitchcock.

Unidentified phanerogams—*Broward Co.: 5444. Dade Co.: 5472, 5705. Duval Co.: 5267. Monroe Co.: 5843. Okeechobee Co.: 5430. Orange Co.: 5376.*

N. Y. BOTANICAL GARDEN,
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Floristic Studies in the Canyon of the Colorado and Tributaries[1]

Elzada U. Clover and Lois Jotter

This report is based upon collections made during the summers of 1938 and 1939. The writers, with four other members of the "Nevills Colorado River Expedition of 1938," navigated the Green and Colorado Rivers from Greenriver, Utah, to Boulder Dam, Nevada, a distance of approximately 660 miles. The period spent in the canyon was forty-two days, from June 20 to August 1, 1938. In view of the fact that the Green and Colorado Rivers serve as a boundary line between counties, it seems advisable to list the chief collection areas alphabetically with counties designated.[2]

Bass Trail, Coconino County, Arizona
Bed Rock Rapids, Coconino County, Arizona
Boulder City, Clark County, Nevada
Bridge Canyon, San Juan County, Utah
Bright Angel Creek, Coconino County, Arizona
Conquistadore Aisle, Coconino County, Arizona
Dark Canyon, San Juan County, Utah
Deer Creek Falls, Coconino County, Arizona
Diamond Creek, Mojave County, Arizona
Dirty Devil River, Garfield County, Utah
Elves' Chasm, Coconino County, Arizona
Emory Falls, Lake Mead, Mojave County, Arizona
Escalante River, Kane County, Utah
Forbidding Canyon, San Juan County, Utah.
Granite Rapids, Coconino County, Arizona.
Greenriver (east bank), Grand County, Utah
Havasupai Canyon, Coconino County, Arizona
Hell Roaring Canyon, Grand County, Utah
Hermit Creek, Coconino County, Arizona
Hite Ranch, Garfield County, Utah
Lee's Ferry, Coconino County, Arizona
Mile 12½ in Marble Canyon, Coconino County, Arizona
Mile 26½ in Marble Canyon, Coconino County, Arizona
Mile 84 on the Green River, Grand County, Utah
Mile Rapids, Cataract Canyon, San Juan County, Utah
Moki Creek, San Juan County, Utah
Mooney Falls, Havasupai Canyon, Coconino County, Arizona
Music Temple, Kane County, Utah
Navajo Falls, Havasupai Canyon, Coconino County, Arizona
North Rim, at Grand Canyon Village, Coconino County, Arizona
Port Royal, North Rim at Grand Canyon, Coconino County, Arizona
President Harding Rapids, Coconino County, Arizona
Quartermaster Canyon, Mojave County, Arizona
Rainbow Bridge, San Juan County, Utah
Rapids 13, Cataract Canyon, San Juan County, Utah
Saddle Canyon, Coconino County, Arizona
Separation Rapids, Mojave County, Arizona
Site of Julian's Name, San Juan County, Utah.
South Rim, at Grand Canyon Village, Coconino County, Arizona
Spencer Canyon, Mojave County, Arizona
Surprise Canyon, Lake Mead, Mojave County, Arizona
Surprise Valley, San Juan County, Utah
Tanner Rapids, Coconino County, Arizona

1 Paper No. 778 from the Department of Botany and the Botanical Gardens of the University of Michigan.

2 Place names along the rivers were taken from U. S. Geol. Surv. Maps. 84, 85.

Ticaboo Creek, Garfield County, Utah
Upset Rapids, Coconino County, Arizona
Vasey's Paradise, Coconino County, Arizona
Virgin Canyon, Clark County, Nevada
Walthenburg Rapids, Coconino County, Arizona
Yokey's Flat, Kane County, Utah.

The senior author spent the summer of 1939 exploring side canyons and collecting at accessible places along the Colorado. Collections were made at Lee's Ferry, on the north and south rims of Grand Canyon, in the Rainbow Bridge Area, in certain selected side canyons along Lake Mead from the head of the lake to the Dam, and in Havasupai Canyon. Detailed work is being continued.

Since the middle of the last century, collections of plants have been made by various botanists on the plateaus and in other areas not far from the Colorado River and tributaries. Botanical specimens from this region were obtained in 1851 by the United States and Mexican Boundary Survey (34); by S. W. Woodhouse of Captain Sitgreaves' expedition (29); by J. M. Bigelow of the Whipple exploring expedition for a railway to the Pacific in 1853-1854 (4); by J. S. Newberry accompanying Lt. J. C. Ives in 1858 (20) up the lower Colorado and into the Grand Canyon region. L. F. Ward, A. S. Hitchcock, Ivar Tidestrom, and A. E. Hitchcock collected in the region of the Grand Canyon in the early 1900's. More recently, Seth Bertram Benson (3) obtained some plants from the Rainbow Bridge area and Navajo Mountain during a biological reconnaissance; Helen Dixon (11) made an ecological study of the high plateaus of Utah; Edward H. Graham (17) did extensive work in the Uinta Basin; Vasco M. Tanner (32) made life-zone studies in southwestern Utah; and Susan D. McKelvey (23) collected yuccas in and near the Colorado Canyon at accessible points. Prior to the present investigations very little botanical work was done within the canyon walls except at Grand Canyon Village. Edwin D. McKee, formerly Park Naturalist at Grand Canyon National Park, is largely responsible for collections used in compiling the check list of Grand Canyon plants (18) although there were also other participants in botanizing in Grand Canyon National Park.

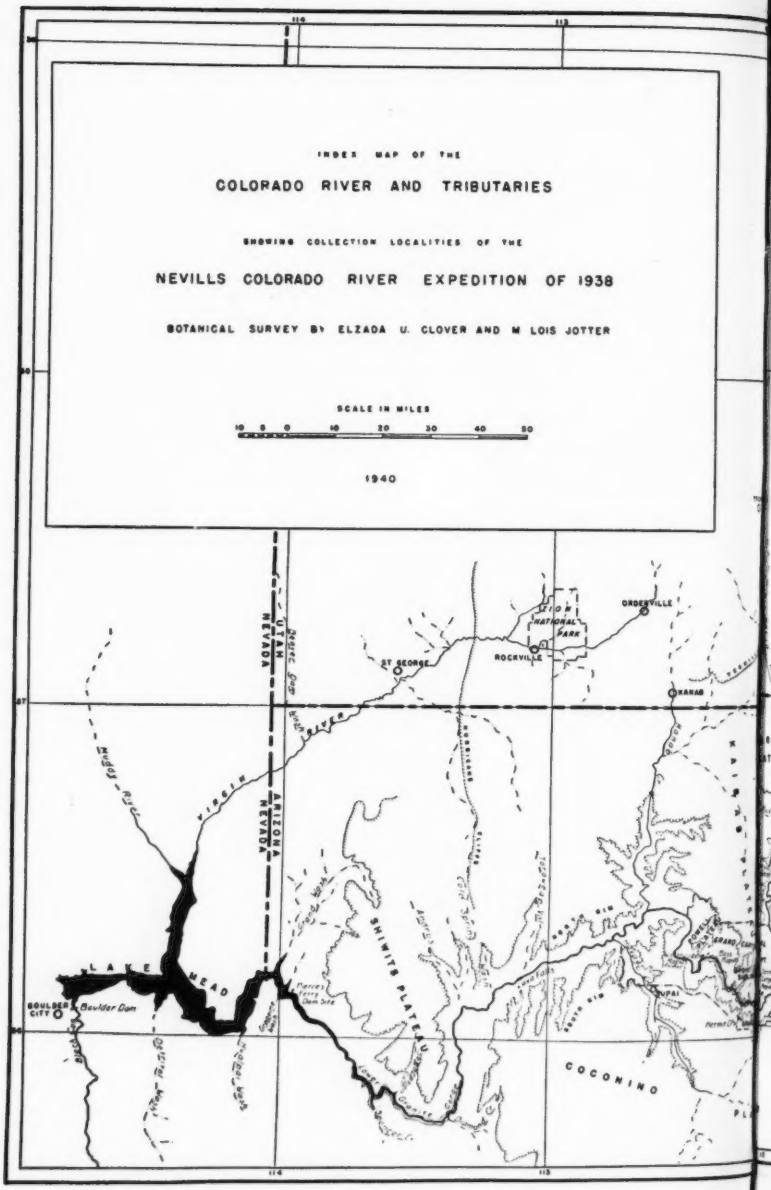
Geology and Physiography

The Colorado River was discovered in 1540 by a detachment of Coronado's party under the guidance of Captain Diaz. About the same time another of Coronado's captains, Cárdenas, took a small band of men, with Indian guides, to the "Famous Cañon of the Colorado" (39).

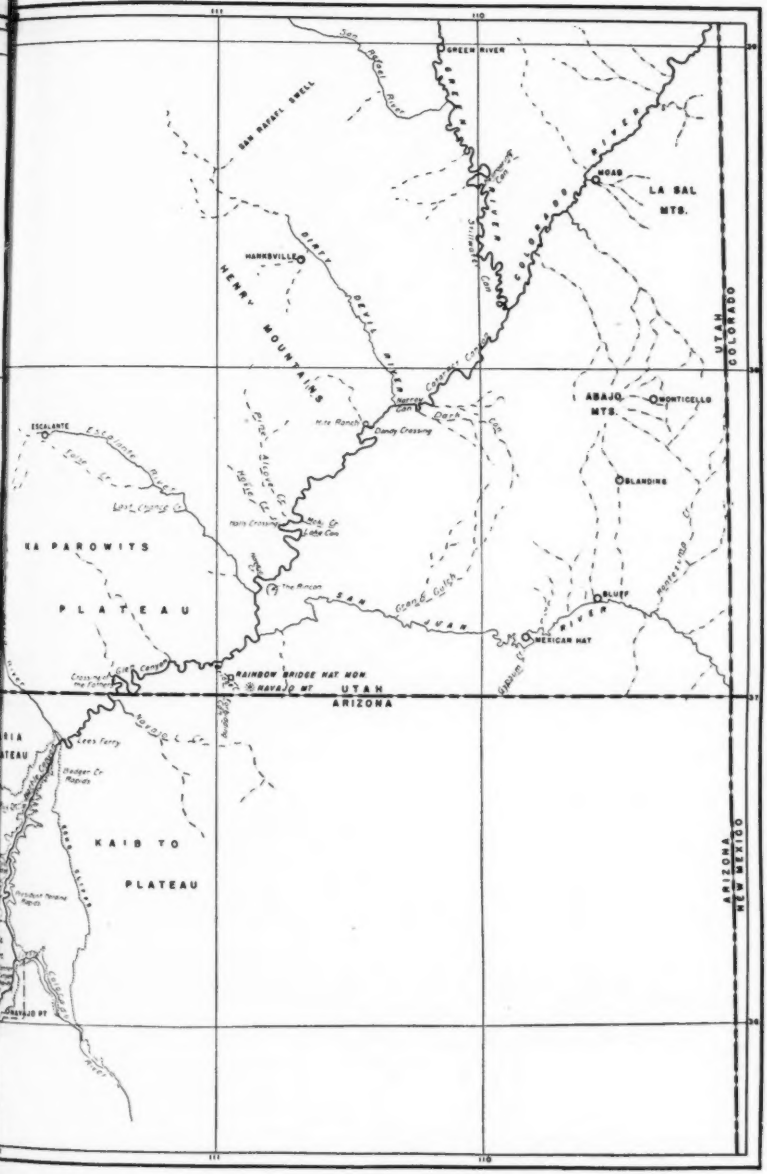
Lieutenant Joseph C. Ives, under the direction of the office of Explorations and Surveys, United States War Department, reported on the geology of the lower regions of the Colorado (20).

Major J. W. Powell, a one-armed Civil War veteran and geologist, in 1869 left Green River, Wyoming, and was the first to travel through the canyons of the Green and Colorado to the Virgin River (28). Two years later Powell repeated the trip (9), this time stopping at Kanab Canyon because of flood waters. Since that time several geological and other expeditions have explored the canyons, without making botanical collections of record.

Fig. 1.—Aerial view of junction of Separation Canyon with the Canyon of the Colorado; inner gorge approximately eight hundred feet deep. Photograph by Fairchild Aerial Surveys, Inc.



Map 1.—Index map of the Colorado River and tributaries. By A. J. Eardley.


GREEN RIVER
MOAB
LA SAL MTS.
HANKSVILLE
HENRY MOUNTAINS
ABAJO MTS.
MONTICELLO
BLANDING
ESCALANTE
KA PAROWITS PLATEAU
BLUFF
MEXICAN HAT
RAINBOW BRIDGE NAT. MON.
NAVAJO MT
UTAH
ARIZONA
KAIB TO PLATEAU
UTAH COLORADO
ARIZONA NEW MEXICO

J. Eardley.

The entire drainage basin of the Colorado comprises 244,000 square miles or one-thirteenth of the area of the United States, and is situated in seven states. Water discharge is from less than 3,000 second-feet during late summer to 200,000 in the highest reported flood stage. Echo Monocline just below Lee's Ferry is an obstacle in the river's path. The cherty limestone and the necessity of eroding this hard rock have delayed erosion, allowing the river above to reduce its course practically to grade (13). The river carries about ten per cent silt, or fine sand, which is the greatest grinding agent. Erosion is aided by the high velocity of the water, which in certain seasons reaches twenty to thirty miles an hour. There are 105,000 acre-feet of silt deposited annually, much of it brought down side canyons.

The present chief tributaries on the east side are the San Juan in southern Utah, the Little Colorado in northern Arizona, and Havasupai Creek. On the west the Dirty Devil (Fremont) River comes in above Hite Ranch, the only habitation along the entire course of the greater Colorado above Boulder Dam. Escalante and Paria Creeks drain the area between this stream and Lee's Ferry. Kanab Creek cuts through the Kaibab Plateau from the north. The waters of Lake Mead now extend thirty miles or more up the Virgin River which drains southwestern Utah and southeastern Nevada.

The San Juan River, entering the Colorado about eighty miles above Lee's Ferry contributes considerable to the already heavy load. Water of the San Juan is used for irrigation in southern Colorado and New Mexico so that the stream is inconsequential in late summer; but trunks of trees and debris found many feet above the canyon floor, and enormous accumulations of coarse alluvium, prove the force of the current during spring floods.

Canyons through which the Green and Colorado Rivers flow have received individual names. To avoid confusion with lateral canyons, those of the main channel from Greenriver downstream are listed as follows: on the Green River, Gray and Labyrinth Canyons; on the Colorado, Cataract, Narrow, Glen, Marble, and Grand Canyons, the latter subdivided into Upper Granite Gorge and Lower Granite Gorge. Cataract Canyon begins at the confluence of the Green and Colorado Rivers and its 63 rapids extend approximately forty-five miles. These rapids are caused by differential erosion of the stream bed and by boulders brought down side canyons during floods. Water percolating through sandstone is stopped by layers of shale high up on the walls. This water, emerging as seeps, softens rock and soil and starts slides. Great boulders, often fifteen feet in diameter, are thrown into the stream or along the shore, and rock fragments accumulate as talus at the foot of walls.

The bed of the Colorado drops 4,000 feet from the mouth of the Green River to the Gulf of California, a distance of 1,215 miles. In its course through the Grand Canyon the stream descends from 3,600 to about 1,000 feet above sea level. The average fall is seven and one-half feet per mile (15). The river, except in extremes of drought or flood, is approximately 300-400 feet wide and about forty feet deep; but in places where the depth is much greater it narrows down to something like fifty feet.

The portion of the river in Grand and Marble Canyons has cut through

Fig. 2.—Aerial view of the Grand Canyon at Hermit Creek to show the various formations. 1. Schists and granites (Archaean Era); 2. Sandstones, limestones and shales (Algonkian Era); 3. Tonto formations (Cambrian Period); 4. Redwell Limestone (Mississippian Period); 5. Supai Sandstone and Shale (Permian Period); 6. Hermit Shale (Permian Period); 7. Coconino Sandstone (Permian Period); 8. Kaibab Limestone (Permian Period). Photograph by Spence Air Photos.

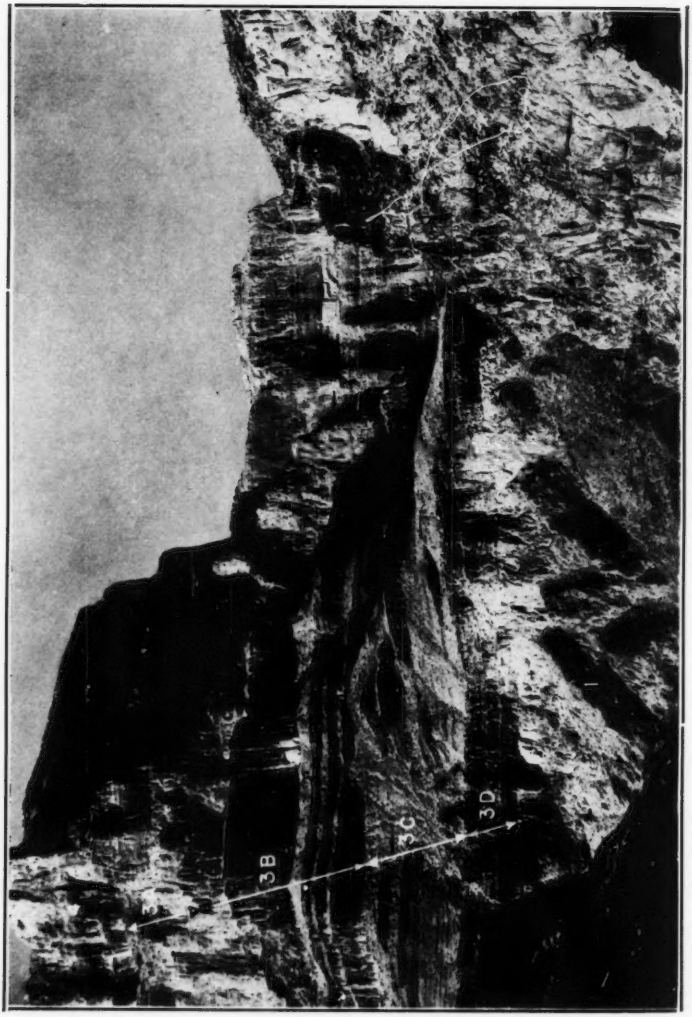


Fig. 3.—Formations of Upper Lake Mead near Surprise Canyon, numbered to correspond with Fig. 2. 1. Pre-Cambrian granites and schists; 3. Tonto formations: 3A. Devonian (no formational name), 3B. Mauv Limestone (Middle Cambrian), 3C. Bright Angel Shale (Lower and Middle Cambrian), and 3D. Tapeats Sandstone (Lower Cambrian); and 4. Redwall Limestone (Mississipian Period). Photograph by George Grant, National Park Service.

numbered to
formations:
Jan), 3C:
Sandstone
graph by

TABLE 1.—Records of Precipitation*

Station	Altitude	Period	Winter			Spring			Summer			Fall			Annual		
			Mean	Driest	Wettest	Mean	Driest	Wettest	Mean	Driest	Wettest	Mean	Driest	Wettest	Mean	Driest	Wettest
Green River, Emery County, Utah	4,087	1931–1939	1.32	.99	1.67	1.26	.57	2.39	1.47	.43	3.17	1.23	.26	2.36	5.28	3.11	7.70
Hite, Garfield Co., Utah	3,500	1900–1914	2.03	.54	2.28	1.56	1.13	3.87	1.43	1.13	.64	2.26	.32	5.57	7.28	3.12	12.36
Escalante, Garfield Co., Utah	5,700	1901–1927	2.76	2.00	3.90	2.08	1.46	1.10	4.05	3.73	9.10	2.94	1.51	7.60	11.83	8.70	21.70
Lee's Ferry, Coconino Co., Ariz.	3,142	1916–1930	1.38	.47	2.60	1.29	.46	2.99	1.88	.10	3.39	1.65	.89	4.09	6.20	3.17	8.41
		1931–1936	1.62	.78	2.58	.94	.34	1.85	2.34	1.36	3.26	1.03	.57	1.35	5.92	4.32	7.25
Grand Canyon, Coconino Co., Ariz.	6,866	1931–1939	4.43	2.06	6.87	2.89	1.64	5.20	3.78	2.00	5.29	3.65	1.21	9.81	14.76	10.43	19.26
Paria, Kane County, Utah	4,700	1895–1900	1.97	1.50	3.30	1.80	.25	4.75	2.69	1.80	2.70	1.99	1.30	3.34	8.45	4.35	14.09
Kanab, Kane County, Utah	4,925	1899–1927	3.82	2.57	6.60	4.05	2.10	8.90	2.96	.96	3.30	3.24	1.66	1.90	14.07	7.29	20.70
		1931–1939	3.18	3.51	7.39	2.46	.47	5.73	2.59	.38	4.57	2.60	.42	8.29	12.86	10.48	14.34
Supai, Coconino Co., Ariz.	3,200	1899–1930	2.46	.07	5.69	1.65	.38	3.48	2.85	.60	10.23	1.93	.57	3.85	8.89	4.50	13.87
		1931–1932	5.75	3.89	7.62	2.11	1.14	3.09	1.61	1.13	2.08	1.20	.35	2.04	10.67	8.46	12.88
Boulder City, Clark Co., Nev.	2,525	1932–1936	1.84	.97	3.15	.47	.21	1.01	1.42	.35	2.91	.93	.07	1.62	4.66	3.11	6.54
		1938–1939	1.93	1.83	2.04	1.76	1.04	2.48	.77	.57	.97	2.36	.54	4.19	6.83	5.63	8.03

* Compiled from Climatological Data: Utah and Arizona Sections, United States Department Agriculture Weather Bureau.

10,000 to 16,000 feet of beds, reaching a maximum depth in the Kaibab Plateau. The present Grand Canyon represents only the erosion through the Carboniferous and the Archaean (Fig. 2). The inner gorge in the Kaibab Plateau section is several hundred feet deep. For a number of miles it is a sharp V-shaped notch cut in the Pre-Cambrian crystalline rocks (2). Walls are high and usually steep, and rapids are numerous for most of the distance between Lee's Ferry and Lake Mead.

Precipitation varies in this desert region from 29 inches annually on Navajo Mountain in southern Utah, to 4.66 inches at Boulder City (Table 1). Few locations except on plateaus have more than 4 to 6 inches annually. Since vegetation is intimately related to the water supply the plant cover is very sparse. "Many plants have no near neighbors; they stand as individuals in tracts of several acres, or are present by two or threes in areas of several miles. Large areas are utterly devoid of vegetation" (19). The above review of some geologic and physiographic aspects of the Canyon Country, with tables on precipitation (Table 1) and temperature (Table 2) will give an idea of the precarious existence of plants growing within the gorges.

Vegetation

Plants which survive here are, in general, those especially adapted to conditions of extreme heat and drought. However, mesophytes and hydrophytes flourish in certain favored situations. The vegetation owes its heterogeneity to a diversity of habitats which depend upon climatic and edaphic factors. Conditions within canyon walls furnish interesting opportunities for microclimatic studies (16,27). Within a small area several separate influences may act as association determiners. Extreme exposure to sun, topographic peculiarities, soil structure, and conditions of moisture may cause variations in a habitat climate. The effect of moisture and shade is exemplified by the plants growing in and near gushing or seeping springs. Hydrophytes and hydromesophytes are able to survive desert temperatures if the immediate habitat is favorable. The exposed side of a canyon may sustain only typical desert scrub and sun-resistant herbaceous plants, while broadleaved trees such as red-bud and hack-berry grow under sheltering overhangs on the opposite, shaded wall. *Primula specuicola, Adiantum Capillus-Veneris* and mosses grow on the under side of the ledges if sufficient moisture is present. Lateral canyons frequently have a more abundant vegetation than is found along the Colorado. This may be accounted for in several ways: (1) sultry updrafts lose their desiccating effect as they leave the main channel; (2) many of these deep canyons are extremely narrow and the sun's rays are directed into them for only brief periods daily; (3) downdrafts caused by the rapid cooling of the desert at night limit the upward progression of lowland plants and at the same time favor the extension of montane species to lower levels.

A collection area of the extent covered in this study naturally has many differences in altitude, latitude, and geologic make-up. For that reason it is impossible to give the composition of definite plant communities as typical throughout the canyon. However, there are similar habitats throughout the portion of the canyon which we visited, and these typical habitats have plant

groupings that change gradually along the course of the river. In order to make it possible to see the changes at a glance, as well as to see what particular types of habitats were either missing, or inaccessible, or not studied within certain stretches, we have prepared a chart (Chart 1) in which the typical habitats are listed horizontally. Vertically from north to south are the several named "canyons" or segments of the big Canyon. Each habitat is therefore dealt with in a vertical column, and by running down a particular column from top to bottom the reader may see the gradual changes in the vegetation of a habitat from north to south. By reading from left to right the names of character plants of all the habitats at a particular locality will pass under the eye, beginning with the moist habitats and ending with the dry upper talus. Collections were made in July and August, too late for ephemerals, which are fairly abundant, judging from the dried remnants.

TABLE 2.—Records of Temperature (Annual)*

Station	Altitude	Mean Temperature	Highest Monthly Mean	Lowest Monthly Mean	Highest Temperature	Lowest Temperature	Years included in record
Greenriver, Utah	4,087	53.5° F	81.1° F	20.7° F	112° F	–42° F	1931–1939
Hite, Utah	3,500	59.7	73.9	45.5	115	–1	
Escalante, Utah	5,700	48.5	71.0	25.4	102	–22	1931–1939
Kanab, Utah	4,925	55.4	76.5	35.9	106	–20	1931–1939
Lee's Ferry, Arizona	3,142	62.1	88.4	36.6	114	5	1931–1936
Grand Canyon, Ariz.	6,866	49.9	71.6	29.1	103	–14	1931–1939
Supai, Arizona	3,200	60.4	79.9	33.6	108	–2	1931–1932
Boulder City, Nevada	2,525	67.5	89.8	45.3	112	12	1932–1936
		66.7	89.6	45.3	112	28	1938–1939

TABLE 2.—Showing annual temperatures at various stations.

* Compiled from Climatological data: Utah Section. United States Department Agricultural Weather Bureau.

TYPICAL PLANT HABITATS (Chart 1)

1. *Margin of moist sand.—Tamarix gallica*,[3] *Baccharis* spp., and *Salix* spp. are most prominent in the vegetation found in wet sand near the river's edge. Northern species of *Baccharis* and *Salix* are supplanted by others farther south, but *Tamarix gallica* grows the entire length of the area studied, with the exception of a considerable stretch in Marble Canyon.

Bowknot Bend, an entrenched meander on the Green River, offers an

3 *T. gallica* was introduced into this country from Europe over one hundred years ago, and has been used as a sand-binding plant on river banks, becoming naturalized.

example of the effect of *Salix* as a soil-binder. Here the red walls of Chinle topped by Wingate sandstone have the usual sparse desert growth which contrasts with the deep green, dense strip of willows at the base of cliffs. The river flows on each side of a sandy flat covered with an equally heavy stand.

In the lower part of the Grand Canyon willows become so well established in some locations as to attain a height of thirty to forty feet (Fig. 6B). High floods may remove so much sand from around the trees that they are torn out completely or barely retain a footing on the crumbling shore until sand again packs around the roots. *Cynodon Dactylon* is an apparently recent colonist which acts as a soil-binder on alluvial flats. It is rapidly becoming established along Lake Mead shores in submerged side canyons and in coves with sufficient detrital deposits.

2. *Springs and waterfalls.*—Gushing springs pour from apertures high on the walls, and seeps may emerge from travertine above impervious shale layers. In such situations hydrophytes and hydromesophytes predominate, although typical desert plants grow almost to the edge of the moist area. Numbers of springs occur along the river's course, but only a few are more than seeps. Vasey's Paradise, named in honor of Dr. George W. Vasey, who was at one time a botanist in the United States Department of Agriculture (Map 1) (Fig. 5A) is a beautiful spring spouting from the wall at least seventy feet above the river. Mosses, liverworts and algae grow in the water and in the spray behind the fall, and a mass of vegetation dominated by *Rhus radicans, Cercis occidentalis,* and *Mimulus cardinalis* flourishes in the moist soil bordering the stream. Deer Creek Falls below Grand Canyon is unusual in having a luxuriant growth of *Phragmites communis, Amorpha truticosa* var. *occidentalis,* and *Urtica holosericea* in addition to plants more commonly occurring in similar situations. *U. holosericea* is reported by Dixon (11) as a montane hydromesophyte; by Tanner (32) as occurring at altitudes of 8,500 to 10,000 feet on the Aquarius Plateau; and Munz (26) mentions the species as growing on the western side of the mountains of California and in the montane zone.

3. *Dry sandy shore.*—Stretches of dry sand undisturbed recently by floods have some of the same plants which inhabit the immediate shore line. These are often somewhat dwarfed or misshapen, and half buried by sand. Atriplex, certain of the Platyopuntiae and grasses predominate, with Phacelia and occasionally Cucurbita along the outer margin. A variation may occur in such situations as at Nankoweap Rapids, where the canyon is wide enough to allow the development of an extensive sandy flat not flooded except in extremely high water. A heavy growth of plants (6) similar to those found on the talus may take hold, and catclaws, cacti and certain tall grasses become the most prominent species.

4. *Rubble and boulder area.*—Great boulders brought down by flood-waters and landslides form an important part of the limited "terrain" within the walls. Smaller water-worn rocks and brush are lodged among them. In such situations, unless frequently subjected to the action of high water, numbers of

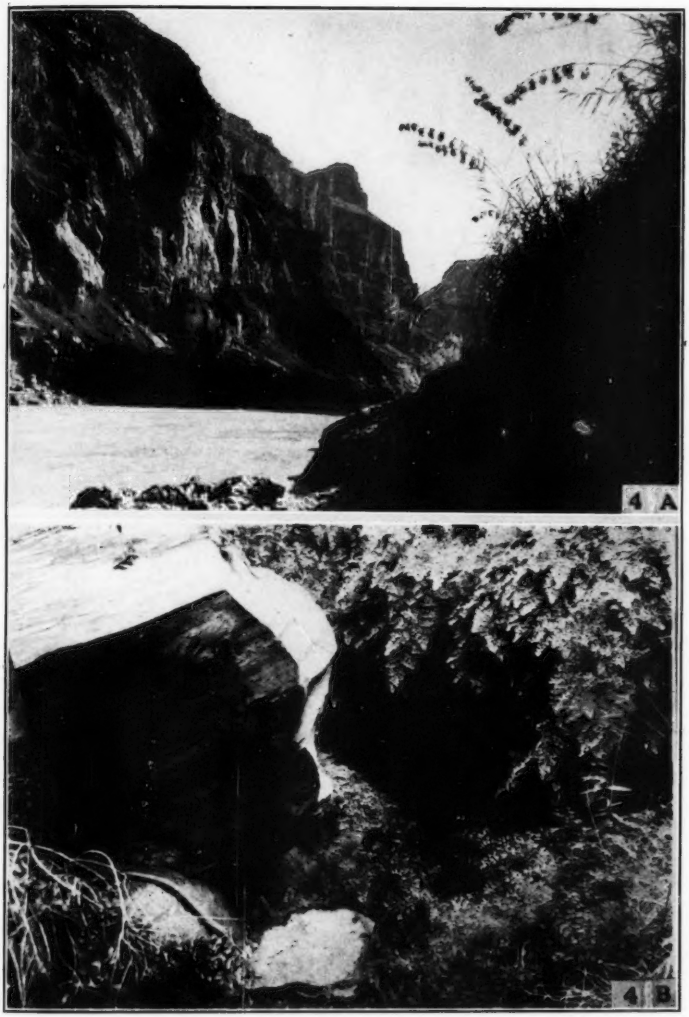


Fig. 4.—A. *Cladium Mariscus californicum* and *Phragmites communis* growing at margin of seepage area near river, Lava Falls (Courtesy of Emery Kolb). B. Spring in recess near mouth of Dark Canyon surrounded by *Adiantum Capillus-Veneris* and *Aquilegia chrysantha*.

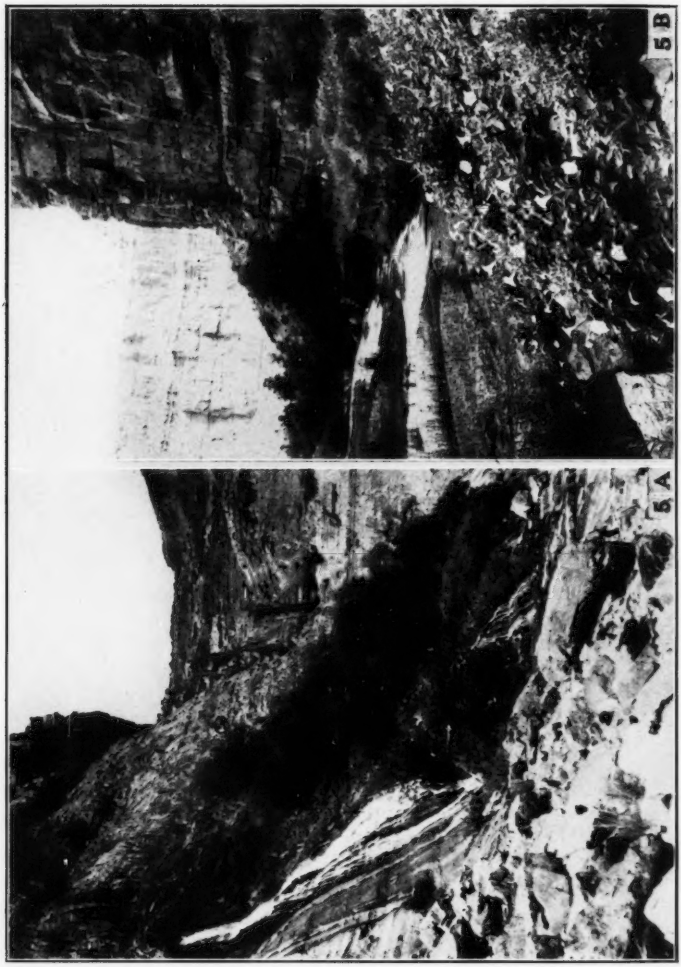


Fig. 5.—A. The effect of moisture at Vasey's Paradise. Dense growth of *Cercis occidentalis* and *Rhus radicans* near fall, in contrast to the xerophytic vegetation on either side. Note figures at base of waterfall. These may serve as a scale of measurement. B. *Datura meteloides* near creek at cliff base, Havasupai Canyon. Willows and cottonwoods are in the background.

plants get a start. These boulders afford shelter for germinating seeds unable to stand the full force of a summer sun. Other plants, brought down by water, and lodged between boulders frequently take root. This rubble and boulder area produces a meager vegetation with the more prominent members consisting usually of *Celtis reticulata, Opuntia brachyclada, O. erinacea, Oryzopsis hymenoides, Cleome lutea, Sphaeralcea grossulariaefolia,* and *Atriplex canescens* in the northern portion; and *Acacia Greggii, Chilopsis linearis, Baccharis glutinosa, Stanleya pinnata, Sphaeralcea grossulariaefolia, Cucurbita* spp., *Oryzopsis hymenoides, Triodia pulchella, Opuntia basilaris,* and *O. erinacea* farther south. Frequently the first plants to come into these areas so often denuded by water are *Oryzopsis hymenoides, Oenothera multijuga,* and *Salsola Kali.*

5. *Talus slopes.*—Attack of weathering and erosion on the walls is mainly directed against the edges of horizontal strata, and variation with respect to durability results in differential weathering with a rapid disintegration of softer beds, forming a talus (Figs. 2 and 3). The harder beds thus undermined, break off at the joints, and fragmental material adds to the talus below. The slopes are in a state of constant change as the older material is being disintegrated and carried off while new is added toward the top. The transitory nature of many slopes, especially in Cataract Canyon, make any but a pioneer vegetation impossible, but at other places with stabilized talus a climax composed of mesquite and Acacia forms a thicket. At President Harding Rapids the shaded portion of the talus is covered from the base to the vertical wall with such a growth (Fig. 8A), which in time will probably cover the remainder now dominated by grasses and cacti.

A series of talus slopes may be seen from the floor to the rim, particularly in Grand Canyon (Fig. 3), many of them with a pitch of forty-five degrees or more. *Ephedra* spp., *Eriogonum inflatum, Atriplex canescens,* and *Oryzopsis hymenoides* are prominent from the lowest to the highest talus throughout the river's course. Dominants on the talus depend on local conditions (Fig. 8B). Gullies on the talus are usually filled with oaks, sumac, and *Cowania. Bernardia incana* and *Mortonia scabrella* var. *utahensis* dominate many such situations in Havasupai Canyon. *Larrea glutinosa* and *Acacia Greggii* may be found separately or together in gullies from Lava Falls to lower Lake Mead. Spencer Canyon is selected to show the type of vegetation to be found on talus in the lower canyon (Fig. 3).

1. Below talus on canyon floor near stream.—*Cynodon Dactylon, Baccharis glutinosa, Heliotropium curassavicum, Datura meteloides, Acacia Greggii, Prosopsis juliflora* var. *glandulosa, Sphaeralcea grossulariaefolia.*

2. Talus of the Pre-Cambrian schists (Fig. 3, No. 1).—*Acacia Greggii* and *Prosposis juliflora* var. *glandulosa* on lower portion forming a thicket, decreasing in size higher on the talus; *Mirabilis Bigelovii, Ditaxis neomexicana, Physalis crassifolia, Eriogonum fasciculatum, Opuntia basilaris, O. Bigelovii, Franseria dumosa, Yucca Whipplei, Triodia pulchella, Bromus rubens, Eragrostis cilianensis, Peucephyllum Schotti, Atriplex canescens* and *Eriogonum inflatum.*

3. On granite, top of the Archaean.—*Phellosperma tetrancistra, Ferocactus acan-*

Chart 1.—Correlation of species growing under similar conditions in certain selected collecti

Location See index map	Altitude	Latitude	Moist sand	Springs and Waterfall
Greenriver, Utah	4,080	39°	*Baccharis Emoryi* *Glycyrrhiza lepidota* *Populus Fremontii* *Rhus trilobata* *Salix amygdaloides* *Sarcobatus vermiculatus* *Scirpus americana* *Tamarix gallica*	Lacking
Hell Roaring Canyon on the Green River	.....	38°30′*	*Baccharis Emoryi* *Salix amygdaloides* *Salix exigua* *Sarcobatus vermiculatus* *Tamarix gallica*	Lacking
Mouth of Dark Canyon in Cataract Canyon	3,510	38°	*Apocynum cannabinum* *Brickellia longifolia* *Cercis occidentalis* *Mentzelia pumila* *Panicum obtusum* *Salix exigua* *Tamarix gallica*	*Adiantum Capillus-Veneris* *Aquilegia chrysantha* *Cercis occidentalis* *Equisetum praealtum*

* Approximately

...as of the Colorado Canyon and tributaries.

Dry sand	Rubble & Boulder Area	Talus	
		Lower Portion	Upper Portion
(Alkali flat) ...pellia scabra ...me lutea ...ptantha crassisepala ...gonum inflatum ...olia lanata ...idium Eastwoodiae ...ntia rhodantha ...opsis hymenoides ...ola Kali ...obatus vermiculatus ...robolus cryptandrus ...da Torreyana ...terocalyx pedun-...latus	(Rocky hillside) *Chrysothamnus viscidiflorus* var. *stenopyllus* *Ephedra Torreyana* *Eriogonum inflatum* *Hilaria Jamesii* *Mentzelia albicaulis* *Mentzelia pumila* var. *multiflora* *Oryzopsis hymenoides* *Sphaeralcea grossulariaefolia*	Lacking	Lacking
Lacking	*Agropyron Smithii* *Atriplex canescens* *Distichlis stricta* *Ephedra Torreyana* *Forestiera neomexicana* *Opuntia hystricina* *Opuntia rhodantha* *Oryzopsis hymenoides* *Rhus trilobata* *Sclerocactus Whipplei* *Triodia pulchella*	Not Collected	Not Collected
Lacking	*Fraxinus anomala* *Juniperus utahensis* *Oryzopsis hymenoides* *Salsola Kali* *Sphaeralcea Fendleri* *Stanleya pinnata* *Stephanomeria pauciflora*	*Apocynum cannabinum* *Astragalus Preussii* *Atriplex canescens* *Celtis reticulata* *Oryzopsis hymenoides* *Phacelia corrugata* *Rhamnus betulaefolia* *Triodia pulchella* *Yucca angustissima*	*Ephedra Torreyana* *Phacelia corrugata* *Rhus trilobata* *Yucca angustissima*

CHART 1.—(Continued)

Location See index map	Altitude	Latitude	Moist sand	Springs and Waterfalls
Mouth of Forbidding Canyon	3,260	37°10′*	*Salix exigua*	Lacking
Rainbow Bridge, 6 miles from the Colorado River (Fig. 1)	3,800	37°10′*	Lacking	*Adiantum Capillus-Veneris* *Agrostis verticillata* *Aquilegia chrysantha* *Cercis occidentalis* *Clematis ligusticifolia* *Juncus Torreyi* *Penstemon ambiguus* *Petalostemon flavescens*
Lee's Ferry	3,148	36°50′*	*Aplopappus acradenius* *Aster spinosus* *Atriplex canescens* *Atriplex Jonesii* *Baccharis glutinosa* *Chrysothamnus nauseosus* *Distichlis dentata* *Glycyrrhiza lepidota* *Salix exigua* and *S. Gooddingi* *Tamarix gallica*	Lacking
President Harding Rapids	2,825	36°30′*	No vegetation (recent deposit)	Lacking

Dry sand	Rubble & Boulder Area	Talus	
		Lower Portion	Upper Portion
Atriplex canescens *Baccharis Emoryi* *Echinocereus Engelmannii* *Ephedra Torreyana* *Oryzopsis hymenoides* *Phellosperma tetrancistra* *Salix exigua* *Salix Gooddingii* *Sclerocactus parviflorus* *Triodia pulchella* *Yucca* sp.	Lacking	(Low horizontal ledge) *Atriplex canescens* *Salix Goodingii* *Salix exigua*	(No talus)
Lacking in area	(On canyon floor) *Atriplex canescens* *Castilleja linariaefolia* *Chrysopsis villosa* *Cleome lutea* *Cowania Stansburiana* *Datura meteloides* *Ephedra Torreyana* *Ephedra viridis* *Frasera utahensis* *Fraxinus anomala* *Funastrum cynanchoides* *Oryzopsis hymenoides* *Panicum virgatum* *Polypogon monspeliensis* *Rhus trilobata*		Very little talus present; due to the nature of the canyon walls of sandstone.
Atriplex canescens *Eriogonum deflexum* *Pluchea sericea*	*Amsonia Eastwoodiana* *Datura meteloides* *Eriogonum inflatum* *Eriogonum Wetherillii* *Parryella filifolia* *Sporobolus cryptandrus* *Xanthium saccharatum*	(On rocky hillside) *Chrysothamnus nauseosus* *Coldenia hispidissima* *Echinocereus Engelmannii* *Ephedra Torreyana* *Franseria acanthocarpa* *Opuntia hystricina* *Salsola Kali*	
Andropogon saccharoides *Atriplex canescens* *Echinocereus Engelmannii* *E. Fendleri* *Ephedra Torreyana* *Lepidium Jonesii* *Opuntia basilaris* *Oryzopsis hymenoides* *Plantago* sp. *Triodia pulchella*	*Dyssodia Thurberi* *Echinocereus Engelmannii* *Echinocereus Fendleri* *Eriogonum inflatum* *Oenothera multijuga* *Opuntia phaeacantha* *Plantago* sp. *Sphaeralcea grossulariaefolia* *Triodia pulchella*	(On western exposure) *Eriogonum inflatum* *Opuntia erinacea* *O. Engelmannii* *Oryzopsis hymenoides* *Plantago* sp. *Triodia pulchella*	In shaded portion of talus *Prosopis juliflora* var. *glandulosa* and *Acacia Greggii*. Very dense, no undercover developed.

CHART 1.—(Continued)

Location See index map	Altitude	Latitude	Moist sand	Springs and Waterfalls
Deer Creek Falls	1,938	36°30′*	*Baccharis Emoryi* *Salix exigua*	*Adiantum Capillus-Veneris* *Amorpha fruticosa* var. *occidentalis* *Apocynum cannabinum* *Baccharis Emoryi* *Phragmites communis* *Urtica holosericea*
Havasupai Canyon (about 8 miles up Supai Creek from the Colorado)		36°10′*	*Baccharis Emoryi* *Pluchea sericea* *Salix* sp. p.	(In creek, and at waterfalls) *Adiantum Capillus-Veneris* *Apium graveolens* *Chara contraria* *Equisetum laevigatum* *Mimulus cardinalis* *Riccia fluitans* *Rorippa Nasturtium-aquaticum*
Lava Falls	1,675	36°10′*	(Moist sandy area from spring to river's edge) *Cladium Mariscus* var. *californicum* *Eleocharis calva* *Eleocharis rostellata* *Phragmites communis* *Salix exigua* *Scirpus Olneyi* *Typha latifolia*	*Adiantum Capillus-Veneris* *Cladium Mariscus* var. *californicum* *Didymodon tophaceus* *Phragmites communis*
Separation Rapids	1,190	36°50′*	No vegetation on river's edge at mouth of Separation Canyon; the following occur up small side canyons of Separation: *Cyperus erythrorhizos* *Juncus Torreyi*	Lacking

Dry sand	Rubble & Boulder Area	Talus	
		Lower Portion	Upper Portion
		Nolina microcarpa *Ephedra Torreyana* *Ephedra viridis* *Oryzopsis hymenoides* *Triodia pulchella*	
(On canyon floor) *Acer interius* *Bouteloua aristidoides* *Clematis ligusticifolia* *Chilopsis linearis* (dry washes) *Cucurbita foetidissima* *Eragrostis trichodes* *Ferocactus acanthodes* *Fraxinus velutina* var. *glabra* *Martynia parviflora* *Oenothera micrantha exfoliata* *Opuntia Engelmannii* *Phellosperma tetrancistra* *Polypogon monspeliensis* *Populus Fremontii* *Salix amygdaloides* *Sphaeralcea grossulariaefolia* *Stanleya pinnata* *Thelypodium Wrightii* *Vitis arizonica*	(At edge of talus) Heavy thicket of: *Acacia Greggii* *Chrysothamnus nauseosus* *Cleome lutea* *Condalia lycioides canescens* *Parthenocissus vitacea* *Prosopis juliflora* var. *glandulosa*		*Agave utahensis* *Nolina microcarpa* *Echinocereus* spp. *Ephedra* spp. *Mortonia scabrella* var. *utahensis* *Opuntia* spp. *Rhus trilobata*
Lacking	Lacking	*Agrostis verticillata* *Baccharis sarothroides* *Cirsium undulatum* *Ferocactus acanthodes* *Gutierrezia* sp. *Larrea glutinosa* *Muhlenbergia asperifolia* —in quantity a short distance above spring. *Notholaena Parryi* *Opuntia acanthocarpa* *Oryzopsis hymenoides*	*Fouquieria splendens* *Oryzopsis hymenoides* *Triodia pulchella*
Chilopsis linearis *Corispermum nitidum* *Cucurbita palmata* *Eucnide urens* *Encelia farinosa* *Franseria acanthocarpa* *Oryzopsis hymenoides* *Salsola Kali* *Tidestromia oblongifolia*	*Aristida glauca* *Brickellia atractyloides* *Eragrostis cilianensis* *Maurandya antirrhiniflora* *Oryzopsis hymenoides* *Polypogon monspeliensis* *Triodia pulchella* *Wislizenia refracta*	*Agave utahensis* *Cryptantha barbigera* *Ferocactus acanthodes* *Larrea glutinosa* *Opuntia basilaris, O. erinacea* & *O. phaeacantha* *Oryzopsis hymenoides* *Triodia pulchella*	

thodes, Opuntia Bigelovii, Larrea glutinosa (stunted), *Bromus rubens, Ephedra nevadensis, Eriogonum inflatum* and *Oryzopsis hymenoides.*

4. Bright Angel Shale (Fig. 3, 3C).—*Fouquieria splendens* (most prominent), *Ferocactus acanthodes, Opuntia basilaris, Acacia Greggii* (stunted), *Larrea glutinosa, Ephedra nevadensis, E. viridis, Sphaeralcea ambigua, Atriplex canescens, Eriogonum inflatum, Triodia pulchella, Eragrostis cilianensis, Oryzopsis hymenoides.*

5. Finely broken granite, north slope.—*Tortula ruralis, Grimmia trichophylla* and lichens.

Plant Distribution

Merriam's (25) delimitation of life zones is useful within the canyon only in a broad way as it is based chiefly on temperature variations as affected by altitude, and fails to take into account that a difference of a single degree in one part of the temperature scale may be of much greater significance than a single degree at another part of the scale. Altitude decreases southward from Greenriver, Utah (4,080 feet), to Boulder Dam (725 feet) as well as downward from the rim to the canyon floor, a change in altitude which may be as much as 7,000 feet. Other conditions such as length of growing season, soils, and moisture must be considered in conjunction with the life-zone concept.

Stanton (31) mentions mixing of zones in mountainous areas. The canyon is comparable in altitudinal changes with a mountain, and we find a similar mixing of zones along the canyon floor and up its sides. Some of the Lower Sonoran plants extend into the Upper Sonoran while those of the upper zone tend to migrate downward.

In a consideration of the northward extension of life zones, the Colorado drainage system must not be overlooked as a possible path of migration for species. The authors are in agreement with Graham (17) that *Fraxinus anomala* and other plants may have entered the Uinta Basin along the channel of the Green River. Tanner (32), in studies made in Utah near the Escalente River about twenty miles northwest of Glen Canyon, mentions that the majority of plants and animals in the Kaiparowits region are of northern origin. In spite of this he believes that the occurrence of a greater number of southern species in the desert and Colorado River portions of this region suggests that the river is serving as a southern portal for invasion by species.

Stanton (31) mentions that fifteen per cent of the flora of Mt. Ellen (northmost peak of the Henry mountains) (Map 1) is composed of plants derived from the Colorado drainage system.

Dixon (11) is of the opinion that some plants in desert canyons of the high plateaus in Utah represent a northern extension of the Lower Sonoran flora. This is attributed partly to the lower altitude and also to the fact that "the water courses of the Colorado River system must serve as the highway of migration for the Lower Sonoran flora, since overland passage to the north is blocked by the high plateaus in Arizona." It seems very logical that the Colorado River should serve as a path of migration for plants. According to our observations, however, there is some discontinuiuty of species, notably in stretches of Marble Canyon. Those requiring a sandy shore have never reached

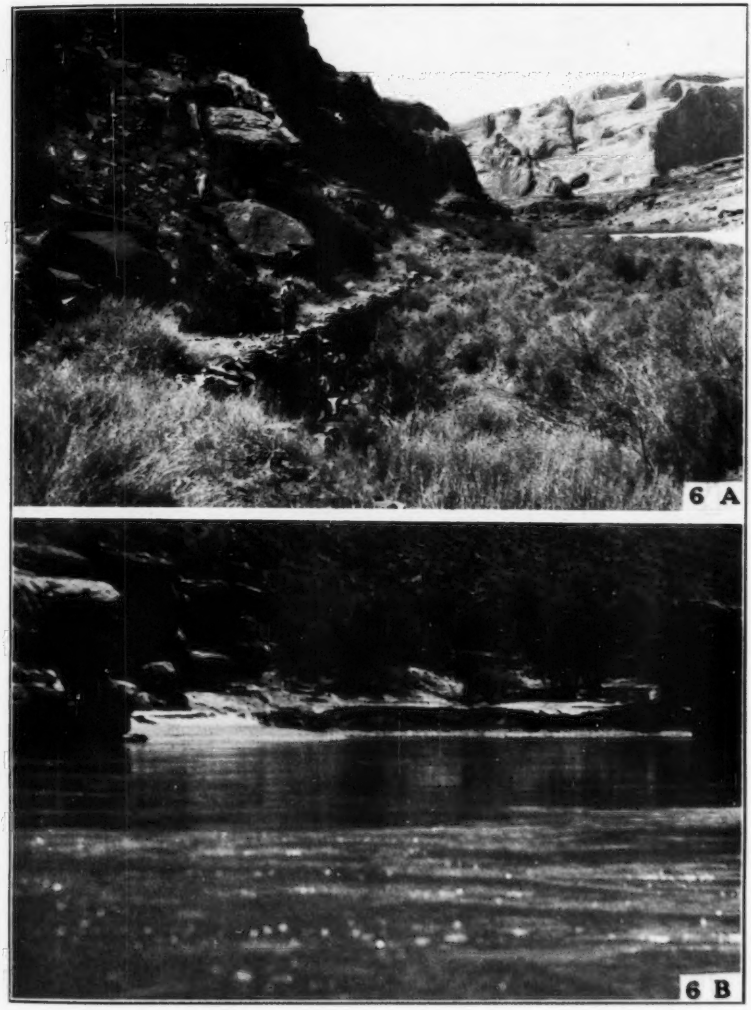


Fig. 6.—A. *Quercus Gambelii* forming a thicket along a rock wall built in Glen Canyon by the Mormons in the early days. B. Willows sometimes grow to a height of thirty or forty feet. A sudden rise in water may entirely or partially uproot them. Lower Grand Canyon.

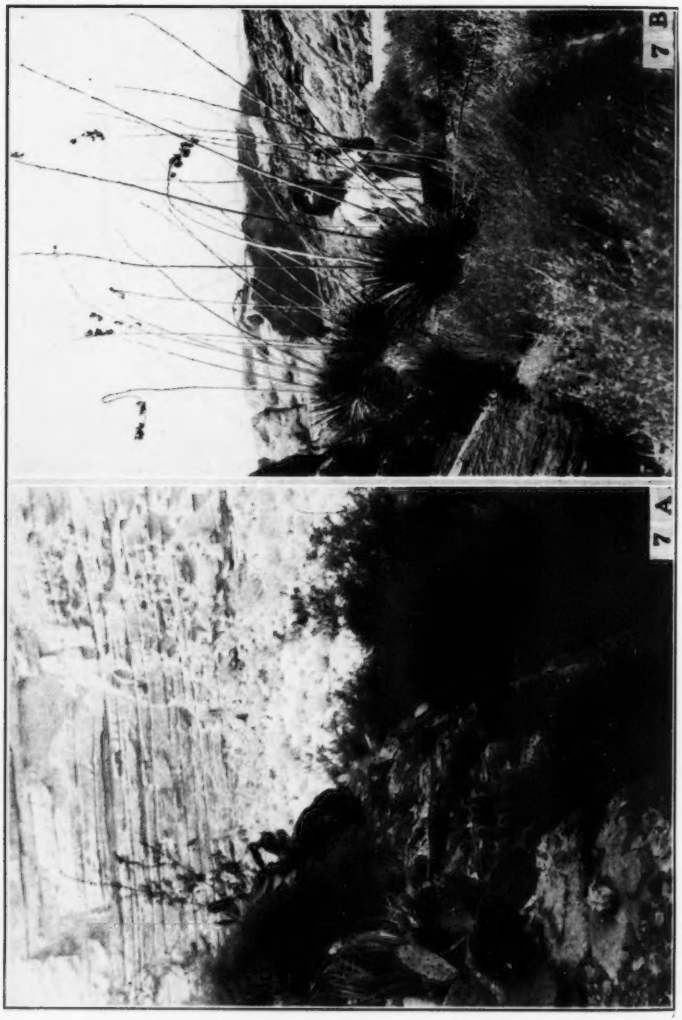


Fig. 7.—A. Plant association on ledge at the head of Havasupai Canyon consisting of *Agave utahensis*, *Opuntia mojavensis*, *Echinocereus coccineus*, some *Acacia Greggii* and grasses. *A. Greggii* forms a dense thicket below the talus. *Atriplex canescens* is most prominent on the canyon floor. B. *Yucca* sp. with flower stalk often reaching a height of ten to fifteen feet, found in Glen Canyon between Hite Ranch and the Mormon trail.

this portion or they have been washed out by floods. In many places water flows against sheer rock walls (at least in flood stage) for several miles. Some of the species which Dixon thought might have entered the plateaus through this channel were not found at all in the canyon. There is a possibility that plants able to tolerate high summer temperatures and drought have traveled northward high on the walls by this route. The winter temperature might be enough warmer below the rim than it is on the plateau to allow their survival.

It is to be expected that the canyon floor would provide better conditions for species of southern latitude than would the desert above. Plants collected indicate this to be true. While Upper Sonoran or Transition zone plants occupy areas on higher lands, typical Lower Sonoran species such as *Acacia Greggii, Prosopis juliflora* var. *glandulosa, Pluchea sericea,* and *Ferocactus acanthodes* extend up the floor of the canyon almost as far as Lee's Ferry, near the northern border of Arizona. *Phellosperma tetrancistra* is found as far north as the mouth of Forbidding Canyon. Judging from the fact that these typical Lower Sonoran species are almost entirely absent above Lee's Ferry, one might be justified in stating that the Lower Sonoran zone does not extend as far as the Dirty Devil River and that beyond thirty-seven degrees latitude the Colorado Canyon is over-rated as a path of migration of southern species. Cottam (7) states that Dixie County in extreme southwestern Utah is the only part of the state having a Southern Desert flora. The plants listed in Dixon's Southern Desert zone include only three which could properly be called Lower Sonoran: *Mirabilis Froebelii* (Behr) Greene (*Quamoclidion Froebelii* Standl.), *Asclepias labriformis* Jones and *Yucca Harrimaniae* Trel. *Mirabilis Froebelii* is reported by Jepson (21) from the San Jacinto Mountains, and from San Felipe, California, and by Munz (26) from Inyo County and the Mojave Desert to the western edge of the Colorado Desert, Nevada, and Lower California. It seems more logical that the species which grows in "draws" (11) has come into this area from the west rather than up the Colorado. *Asclepias labriformis* is reported from southern Utah by Tidestrom (33) growing in canyons and on dry hillsides of the Artemisia and Pinyon belt, *Yucca Harrimaniae* by Tidestrom (33), and by Wooton and Standley (40) from southern Utah and Colorado, northeastern Arizona and northwestern New Mexico. We found *Y. Harrimaniae* in the vicinity of Moab and southward, and *Asclepias labriformis* in Surprise Valley, where it has probably come in from the upland. It seems more likely that these southern plants of higher altitudes have been distributed northward on desert plateaus rather than up the canyon floor.

Acer interius reported by Dixon grows also in Glen Canyon across the river from "Music Temple," and in Havasupai Canyon. It may have traveled by way of the canyon but certainly cannot be called "Lower Sonoran," as it occurs as far north as Saskatchewan and Manitoba. This species and *Amorpha fruticosa* var. *occidentalis, Fraxinus velutina* var. *glabra* and *Juglans rupestris* might be explained as relicts of an earlier mesophytic flora. Such grasses as *Andropogon barbinodis, A. glomeratus, A. saccharoides, Sporobolus cryptandrus, Digitaria sanguinalis, Echinochloa Crusgalli* var. *zelayensis, Elymus canadensis, Hilaria Jamesii, Muhlenbergia asperifolia,* with *Cercis occidentalis*

may have remained in the canyon long after the species of a mesophytic or a prairie flora had vanished. Clements (5) finds that canyon walls afford protection from grazing, and states that he is almost sure of locating relicts along canyon edges and on the floor, especially near protecting boulders. *Sporobolus* and *Andropogon* are more apt to be found on the side receiving most protection from the sun's rays. *Cercis, Muhlenbergia, Digitaria* and *Echinochloa* are found in abundance near water, and certainly could not exist on the blistering desert.

One might speculate further regarding relict vegetation within the canyon, suggesting that shrubs extended northward "on top," probably during drier conditions of the Miocene, when the present drainage system was already in existence. Later, grasses came in as a result of greater precipitation. Shrubs remained as relicts on dry exposed walls during the subsequent wet phase, finally becoming established on floors of canyons under present desert conditions.

METHODS OF DISTRIBUTION

Landslides and floods are rapid and effective means of plant distribution characteristic of canyons. Large blocks of rock break off high walls initiating slides of such magnitude that all vegetation is swept down with them, often to be buried in the talus below. Occasionally seeds or vegetative portions of plants not covered by debris become established at lower levels in the canyon. Cylindropuntiae found on talus near the river in Lower Grand Canyon were probably brought down vertically in this way.

Floods are frequent along the Colorado. Increases in volume of water may occur either sporadically as the result of local cloudbursts near side canyons, or seasonally, because of the melting snow and spring rains near the source. A sudden rise in water level will result in flooding of low, sandy areas, the drowning of some plants, and the ripping out of others. In this canyon the natural tendency for plants to migrate downstream is accelerated by sudden variations in water level and velocity resulting from floods. Cacti, willows and *Tamarix* transported by water will root if given an opportunity.

Species of steep slopes or high ledges are aided in seed dissemination by gravity. *Pinus edulis* and *Juniperus utahensis* in Surprise Valley above Rainbow Bridge may be found from the rim to the floor of the canyon, usually singly or in small clumps in pockets of sandstone. Air-borne seeds may be carried vertically by the down drafts of cool air peculiar to the canyons and resulting from the rise of superheated air in the central gorge. In addition to this down current, winds blowing daily from the warmer areas downstream distribute seeds horizontally.

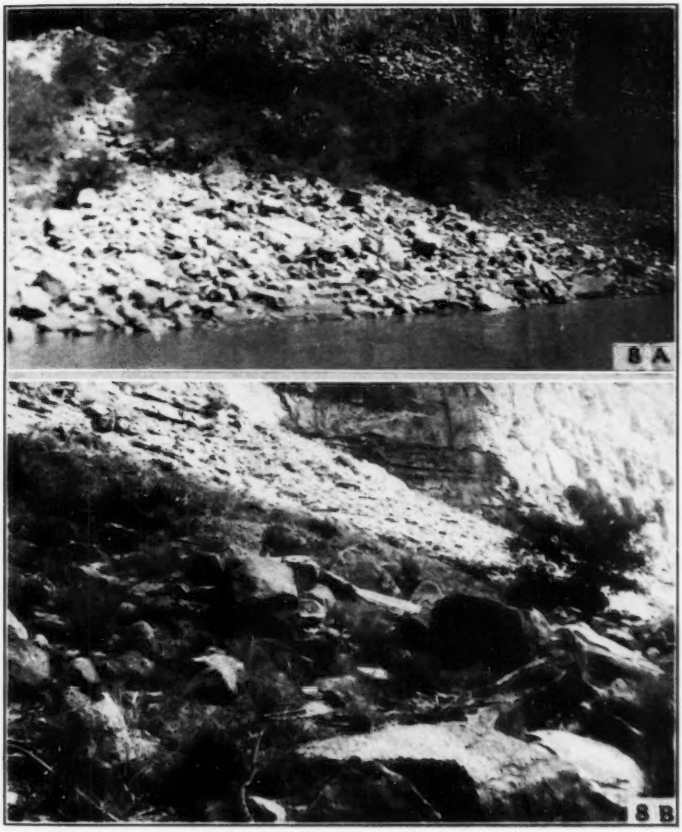


Fig. 8.—A. Climax composed of *Acacia Greggii* and mesquite on talus below President Harding Rapids in Marble Canyon. B. Talus near Rapids 13 of Cataract Canyon, with *Oryzopsis hymenoides* forming typical clumps. The tree is *Celtis reticulata*, twenty feet in height. Species of Ephedra are common on the upper portion.

Some Relations of Birds and Mammals to Plant Life in the Canyons

Plants have some dependence upon birds and mammals, especially for seed distribution, which is in part accomplished through the dung of animals; and it is not a little interesting that our knowledge of the late geological occurrence of certain living species of plants has been derived from botanical analysis of the dung of recently extinct animals.

The following species were identified from dung of the extinct giant ground sloth (*Nothrotherium*) remains of which were found in Rampart and Mauv Caves on Lake Mead (22): *Larrea divaricata* (=*glandulosa**), *Nolina Bigelovii, Yucca mojavensis, Sphaeralcea ambigua**, *Adiantum Capillus-Veneris**, *Atriplex hymenelytra**, *Cassia Covesii**, *Ferocactus acanthodes**, and *Ephedra nevadensis**. It is interesting to note that most of these species (marked by an asterisk) are growing along Lake Mead today, and new comparisons should be made to insure the correctness of the identifications of the rest.

Time and a particular technique are required for accurate field study of distribution and feeding habits of animals. This brief account, therefore, is not the result of detailed investigation (for which there was no opportunity), but a record of casual observations made during the time spent in the Canyon Country, combined with authoritative information on feeding habits from published and unpublished sources (12, 38, 35).

Mule deer apparently range over much of the desert adjacent to the Colorado. They come down side canyons to water singly or in twos and threes. Browsing in an area of such limited growth as is common in the canyon may seriously affect spread of a plant species. The big horn mountain sheep inhabit high, dry ledges along the river, and were observed by the writers at the lower end of Cataract Canyon in Utah, on the San Juan River about twenty miles above its mouth, below Deer Creek Falls, at the mouth of Havasupai Canyon and on upper Lake Mead below Separation Rapids. They appeared usually in bands of from five to ten. These rare animals live on an extremely small amount of water (38) and depend partly on certain members of the Platyopuntiae and on Ferocactus as a source of supply. The rather bitter, gelatinous pulp contains considerable water. Beavers live in banks of the river and apparently subsist largely on willows. Herds of burros roam the deserts below Grand Canyon feeding on tufts of grass and shrubby plants. They are increasing in number to the extent of becoming a nuisance, threatening to deplete the supply of forage plants available for deer and mountain sheep. Range cattle graze at mouths of side canyons on their periodic trips to water.

Hoofed animals are doubtless responsible for seed distribution from one locality to another. Fruits of mesquite are greatly favored by most desert animals as food and the seeds are still viable after passing through the digestive tract. Russel Grater, former Park Naturalist at Lake Mead, made a study of feeding habits of animals. He observed that the pocket mouse ranged from rim to floor of the canyons and stored seeds on overhanging cliffs. These seeds often germinated and produced plants or fell to lower ledges. Thus

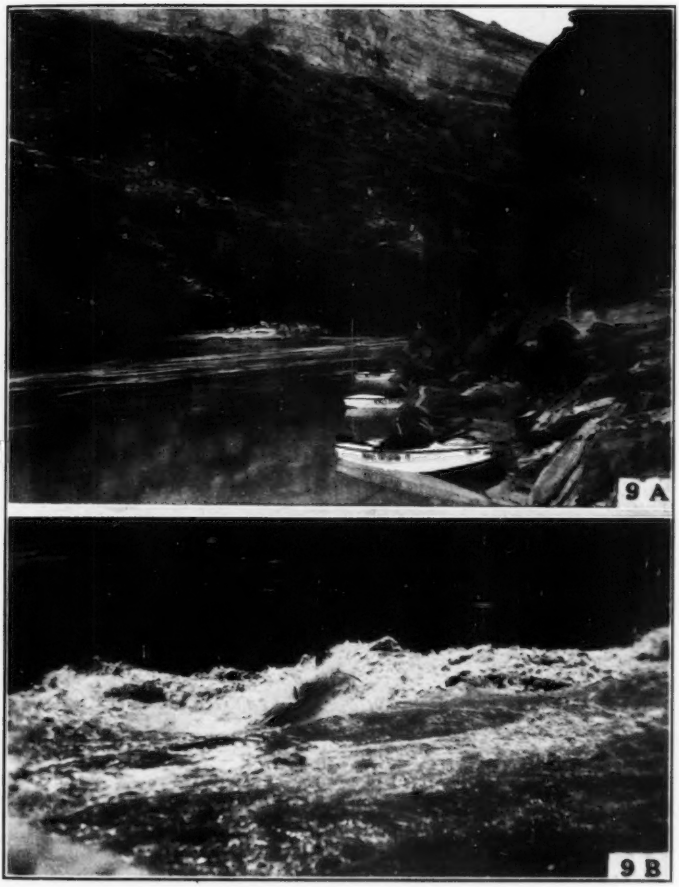


Fig. 9.—A. In Marble Canyon marginal sand bars are lacking for some miles, and in places very little vegetation is found on the steep walls. B. The boatman throws himself forward to prevent the boat from standing on end in Upset Rapids. All botanical materials were carried in waterproof hatches.

migration vertically is aided materially. Other small mammals of the desert of equal importance in seed dissemination are the wood rat, kangaroo rat, harvest mouse, white-footed mouse, antelope squirrel, rock squirrel and chipmunk. The numerous birds inhabiting canyon and desert cannot be ignored as a factor in seed dispersal.

Conclusions

1. Owing to constantly changing conditions of the talus caused by landslides, and of the river's edge in consequence of periodic floods, there is little climax vegetation in the Canyon of the Colorado. However, vegetation may remain undisturbed for years, chiefly at springs and on stabilized portions of the lower talus.

2. Although the Colorado Canyon serves as a path of migration for Lower Sonoran species it is apparently not so important as previously supposed, i.e., typical Lower Sonoran species are not found in the canyon much above Lee's Ferry, Arizona. Therefore, migration up the river has either taken place in the past, or plants with southern affinities have migrated "overland," or southern plants at the northward are relicts of formerly more widespread distribution.

3. There are evidences of relicts of prairie, mesophytic, hydromesophytic and hydrophytic floras in the canyon. Numerous grasses, as *Sporobolus, Andropogon;* such trees as *Fraxinus velutina* var. *glabra, Cercis* and *Acer interius; Adiantum Capillus-Veneris, Epipactis gigantea, Aquilegia chrysantha,* mosses and algae serve as examples of species typical of floras existing in a more favorable climate. The northern extension of shrubs in the canyon may possibly be explained by the alternation of dry and moist periods dating back to the Miocene. Shrubs may have advanced "overland" during a dry period, and survived on dry canyon walls under conditions of too much moisture. With the present extreme desert climate they now persist in protected pockets and on shaded walls of side canyons, and in the Canyon of the Colorado.

4. Altitude, moisture, light and temperature are more influential in determining the range of species within the canyon than are the underlying geologic formations.

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Plant List

BRYOPHYTA

HEPATICAE

Ricciaceae

Riccia fluitans L. (4372) (5016) (5017) (5214) (5215) (5216). In stream and irrigation ditches above village in Havasupai Canyon.

MUSCI

Pottiaceae

Barbula Ehrenbergii (Lor.) Fleisch. Common on walls at Emory Falls on Lake Mead (4195); near seep in wall two miles above Emory Falls (4297A); edge of pool below waterfall (5238) (5240) (5242) (5298), Mooney Falls (5304), and travertine formed from this species at Mooney Falls (5291) in Havasupai Canyon.

Didymodon mexicanus Besch. var. subulatus Thér. & Bartram. Conquistador Aisle (2321A).

Didymodon tophaceus (Brid.) Jur. Two miles above Emory Falls (5293) (5297).

Didymodon trifarius (Hedw.) Brid. Edge of spring (5206), and edge of pool below waterfall (5239) (5241) (5301) in Havasupai Canyon.

Eucladium verticillatum (Brid.) Bry. eur. Dark Canyon (2179) (2180A); President Harding Rapids (2284A); at 50 Foot Falls (5212), and Navajo (Bridal Veil) Falls (5302) in Havasupai Canyon.

Pleurochaete squarrosa (Brid.) Lindb. Vasey's Paradise (2251A); Bed Rock Rapids (2337); at spring in Havasupai Canyon (5212B).

Tortula atrovirens Lindb. (Desmatodon convolutus (Brid.) Grout) Dark Canyon near spring (2181); dry talus slope in Havasupai Canyon (5299).

Tortula aurea Bartram. Conquistador Aisle on dry soil (2321B).

Tortula inermis (Brid.) Mont. Mile 26½ in Marble Canyon (2237A); common in seepage area, Deer Creek Falls (2337A).

Tortula obtusissima (C. Müll.) Mitt. On talus in Dark Canyon (2181A); Conquistador Aisle (2321B).

Tortula ruralis (Hedw.) Smith. Dark Canyon (2181B); Deer Creek Falls (2337B); on dry walls in Spencer Canyon (4257A) (4258).

Grimmiaceae

Grimmia trichophylla Grev. at Mile 26½ in Marble Canyon (2238); Tanner Rapids among boulders (2300A); near Bass Trail on rocks covered with sand (2304); on dry walls of Spencer Canyon (4257).

Funariaceae

Funaria hygrometrica Hedw. In spring (5205) and at 50 Foot Falls (5218) in Havasupai Canyon.

Funaria Muhlenbergii Turn. Conquistador Aisle (2321C).

Bartramiaceae

Philonotis capillaris Lindb. Vasey's Paradise (2249) (2250).

Bryaceae

Bryum cirratum Hoppe & Hornsch. Dark Canyon near spring (2181C).

Hypnaceae

Campylium chrysophyllum (Brid.) Bryhn. Dark Canyon near spring (2180); Havasupai Canyon in springs (5219) (5220) (5236) (5237) (5269) (5301) (5304A).

Eurhynchium rusciforme (Neck.) Milde. At Mile 26½ in Marble Canyon (2236A); Elves' Chasm at water's edge (2320).

Hygroamblystegium orthocladon (Beauv.) Grout. Vasey's Paradise on rocks splashed by water (2246) (2247); growing under water, near village in Havasupai Canyon (5221).

PTERIDOPHYTA

Polypodiaceae

Adiantum Capillus-Veneris L. Cataract Canyon at mouth of Dark Canyon (2137) (2138); Rainbow Bridge (4032); Marble Canyon at Mile 26½ (2234); and Vasey's Paradise (2244); in Grand Canyon at Deer Creek Falls (2339), Havasupai Canyon (4407) (4422A), Lava Falls (2361); on Lake Mead two miles above Emory Falls (4283) (4295A), and at Emory Falls (4193).

Cheilanthes Feei Moore. Near mouth of Dirty Devil River in Narrow Canyon (2185).

Notholaena Jonesii Maxon. Fairly abundant at Vasey's Paradise (2254) in Marble Canyon. Maxon reports this as rare.

Notholaena limitanea Maxon. Near mouth of Dirty Devil River (2183); Vasey's Paradise (2253).

Notholaena Parryi D. C. Eaton. In Grand Canyon at Lava Falls (2363), Deer Creek Falls, Mile 193 (2387), and at mouth of Spencer Canyon (4255A).

Equisetaceae

Equisetum laevigatum A. Br. Above village (4403) and at mouth of Havasupai Canyon (2359).

Equisetum praealtum Raf. At site of Julian's name on the Green River (2063); mouth of Dark Canyon (2152); Surprise Valley and Bridge Canyon; Vasey's Paradise in Marble Canyon (2252).

SPERMATOPHYTA

GYMNOSPERMAE

Pinaceae

Juniperus scopulorum Sarg. Rapids 13 in Cataract Canyon (2127B). The only specimen found along the entire course of the river; dwarfed, 1½ feet tall and growing on canyon floor.

Juniperus utahensis (Engelm.) Lemmon. Outside the canyon between Greenriver and Moab (1969); five miles above the confluence of the Green and Colorado Rivers (2109); above Dark Canyon (2182); Surprise Valley and Rainbow Bridge; upper walls of Havasupai and Hualapai Canyons.

Pinus edulis Engelm. Between Navajo Mt. and Rainbow Bridge and in Surprise Valley; common on North Rim (4301); South Rim; Hualapai Canyon.

Gnetaceae

Ephedra Coryi Reed (or E. viridis Cov.; species not distinguishable without fruit). Port Royal on North Rim (4322) (4323); between Mooney Falls and the Colorado in Havasupai Canyon (4421); Spencer Canyon (4255); Quartermaster Canyon.

Ephedra nevadensis S. Wats. Spencer Canyon (4256).

Ephedra Torreyana S. Wats. Greenriver (1958); on the Green River at Mile 84 (2047) and near mouth of Hell Roaring Canyon (2073) (2088); in Cataract Canyon at Rapids 13 (2130), and at mouth of Dark Canyon (2148); Lee's Ferry (4343) (4422); in Marble Canyon at Mile 26½ (2233), and at Vasey's Paradise (2266); Tanner Rapids (2295), and above Bass Trail in Grand Canyon (2308).

Ephedra trifurca Torr. Near Boulder Dock (4190).

Ephedra viridis Cov. Forbidding Canyon (4069); ½ mile below South Rim near Kaibab Trail (4133); above Bass Trail (2309); mouth of 205 Mile Canyon (2386); Separation Canyon (4249); below Quartermaster Canyon; two miles above Emory Falls; below Virgin Canyon.

ANGIOSPERMAE

Typhaceae

Typha angustifolia L. Bridge Canyon; near Colorado River in Havasupai Canyon. (Too old for herbarium material.)

Typha latifolia L. Elves' Chasm; in Havasupai Canyon near the village; Lava Falls. (Too old for herbarium material.)

Gramineae

Agrostis alba L. Upper Kaibab Trail, South Rim (4120).

Agrostis verticillata Vill. Rainbow Bridge (4033) (4047), Bridge Canyon (4042), aand floor of Forbidding Canyon (4071); mouth of Bright Angel Creek (4086) (4094A) (4101); Hermit Rapids (2290A); Havasupai Canyon (4415); Lava Falls (2378); along stream at Separation Rapids (4203); Surprise Canyon (4269).

Agropyron Smithii Rydb. At ancient Indian granaries above Hell Roaring Canyon (2095); Cataract Canyon below Rapids 7 (2110).

Andropogon barbinodis Lag. Hermit Rapids (2289A).

Andropogon glomeratus (Walt.) B. S. P. Mouth of Bright Angel Creek (4089).

Andropogon saccharoides Swartz. In Marble Canyon at Mile 26½ (2230), and Vasey's Paradise (2256).

Aristida Adscensionis L. Mouth of Bright Angel Creek (4085) (4098).

Aristida glauca (Nees) Walp. Although not reported by Dixon or by Graham, this species was found in Utah on the Green River at Hell Roaring Canyon (2085); below Mile Rapids in Cataract Canyon (2115); in Marble Canyon at Mile 26½ (2222), President Harding Rapids (2277); mouth of Bright Angel Creek (4099); mouth of Diamond Creek (2392); Separation Rapids (4200) (4205).

Aristida longiseta Steud. Greenriver (1955); near Moab (2011). Although Hitchcock reports the species from Arizona, it was not found within the Canyon.

Avena sativa L. Depauperate form found on the second half mile of Kaibab Trail, South Rim (4136); probably dropped from feed bags on trail.

Bouteloua aristidoides (H.B.K.) Griseb. Near Creek in Havasupai Canyon (4377).

Bouteloua barbata Lag. Common in sand and gravel along stream in Separation Canyon (4198).

Bouteloua curtipendula (Michx.) Torr. Near Rainbow Bridge (4036).

Bouteloua Parryi (Fourn.) Griffiths. Among boulders in Separation Canyon (4201).

Bouteloua trifida Thurb. Surprise Canyon on Lake Mead (4207); abnormal spikelets with elongated awns.

Bromus ciliatus L. Upper Kaibab Trail on South Rim (4114).

Bromus rigidus Roth. Mouth of Havasupai Canyon (2356).

Bromus rubens L. Two miles above Emory Falls (4295). Common along the lake, often dwarfed.

Bromus tectorum L. Mouth of Dark Canyon (2159).

Cenchrus pauciflorus Benth. Edge of cornfield in Havasupai Canyon (4398).

Cynodon Dactylon (L.) Pers. Common along Bright Angel Creek (4081); in Havasupai Canyon abundant from village to Colorado River (2358); common at water's edge in Separation Canyon (4199). This species is found only where water is available.

Digitaria sanguinalis (L.) Scop. Near stream above village in Havasupai Canyon (4404).

Distichlis dentata Rydb. Along river at Lee's Ferry (2195).

Distichlis stricta (Torr.) Rydb. Green river (1926); Hell Roaring Canyon (2080).

Echinochloa Crusgalli var. *zelayensis* (H.B.K.) Hitchc. At edge of cornfield in Havasupai Canyon (4399).

Elymus canadensis L. Floor of Forbidding Canyon (4062); Vasey's Paradise (2269).

Eragrostis cilianensis (All.) Link. Spencer Canyon (4263); from Separation Canyon to Emory Falls.

Eragrostis diffusa Buckl. Near stream above village in Havasupai Canyon (4402) (4403).

Eragrostis trichodes (Nutt.) Nash. Along irrigation ditch in Havasupai Canyon (4367A).

Festuca octoflora Walt. Below Mile Rapids in Cataract Canyon (2126); Hermit Rapids (2288A); Tanner Rapids (2294).

Hilaria Jamesii (Torr.) Benth. Although this species is reported throughout Utah, and is used by the Indians in the Painted Desert of Arizona, we failed to find it farther south than Mile 84 on the Green River. Greenriver (1954); roadside east of Greenriver (1968) and at Mile 84 (2054).

Hordeum jubatum L. Greenriver (1921), and at ancient Indian granaries above Hell Roaring Canyon (2092); Navajo Mt.; Kaibab limestone on the South Rim.

Imperata Hookeri Rupr. Mouth of Bright Angel Creek (4096); mouth of Havasupai Canyon (2353).

Lolium perenne L. Mouth of Bright Angel Creek (4094).

Muhlenbergia asperifolia (Nees & Mey.) Parodi. Mouth of Bright Angel Creek (4083); very abundant at Lava Falls (2365).

Oryzopsis hymenoides (Roem.. & Schult.) Ricker. This species is one of the most common along the river, and occupies recently flooded areas soon after the water recedes. Greenriver (1917) (1978A) and Mile 84 (2043); in Cataract Canyon below Mile Rapids (2116), and common at mouth of Dark Canyon (2172); in Marble Canyon at Mile 26½ (2223), and common at President Harding Rapids; common on South Rim and on North Rim at Port Royal (4326); common at Hermit Rapids; at Elves' Chasm (2233); common at Separation Rapids (4223); Boulder Dock (4186).

Panicum hirticaule Presl. Occasional at Separation Rapids (4229).

Panicum obtusum H. B. K. Mouth of Dark Canyon (2144).

Panicum virgatum L. Bridge Canyon (4043); floor of Forbidding Canyon (4059).

Phragmites communis Trin. Above Hell Roaring Canyon (2057); common in the vicinity of Paiute Farms on the San Juan River; mouth of Bright Angel Creek; in Grand Canyon at Deer Creek Falls (2341), two miles south of Upset Rapids, infrequent about a mile above Havasupai Canyon, and below village in Havasupai Canyon.

Poa longiligula Scribn. & Williams. Mouth of Dark Canyon (2162).

Polypogon monspeliensis (L.) Desf. Among rocks and on sand near Rainbow Bridge (4035), floors of Bridge and Forbidding Canyons (4063); in Grand Canyon at Tanner Ropids (2291), mouth of Bright Angel Creek (4088); Havasupai Canyon from the village to the Colorado River (2354) (4414); common at Separation Canyon (4230).

Setaria lutescens (Weig.) Hubb. Hitherto not reported from Arizona. Cornfield above village in Havasupai Canyon (4396A). Introduced.

Setaria macrostachya H.B.K. President Harding Rapids; mouth of Bright Angel Creek (4082); Elves' Chasm (2334); above village in Havasupai Canyon (4396).

Setaria viridis (L.) Beauv. Hitchcock reports this species as infrequent in southern United States although common in cooler U. S. and Canada. This collection is the first from the canyons. Edge of cornfield in Havasupai Canyon (4397A).

Sitanion hystrix (Nutt.) J. G. Smith. Fairly abundant south of Moab (1998); common on the Colorado about a mile above the mouth of Havasupai Canyon.

Sitanion jubatum J. G. Smith. Third half mile near the Kaibab Trail on the South Rim (4147).

Sporobolus airoides (Torr.) Torr. Mile 84 on the Green River (2049).

Sporobolus contractus Hitchc. First collections from within the canyon. Floor of Forbidding Canyon (4064) (4066) (4070); Granite Rapids in Grand Canyon (2301A).

Sporobolus cryptandrus (Torr.) A. Gray. First collections from within the canyon. Greenriver (1916); Lee's Ferry near the Colorado (4353); four miles up Havasupai Canyon (4423); among boulders at Separation Canyon (4202).

Sporobolus flexuosus (Thurb.) Rydb. Below Mile Rapids in Cataract Canyon (2125); Kanab Trail (2345).

Stipa arida Jones. Mile 26½ in Marble Canyon (2209). Hitchcock reports this as rare.

Stipa comata Trin. & Rupr.? Mouth of Dark Canyon (2159).

Stipa coronata Thurb. The first collection from Arizona, although Hitchcock's collection (13062) from Bright Angel is referred to a variety. This collection is nearly as tall as that of Hitchcock but the panicle is smaller. Fourth half mile near the Kaibab Trail on the South Rim (4157).

Stipa spartea Trin. Outside the canyon south of Moab (2008) below Mile Rapid in Cataract Canyon.

Stipa speciosa Trin. & Rupr. Below Mile Rapids in Cataract Canyon (2119) (2120) (2127A); Mile 26½ in Marble Canyon (2231); first half mile near the Kaibab Trail on the South Rim (4131).

Triodia pulchella H. B. K. Common along the Green and Colorado Rivers, from the lower edge of the talus slopes to high ledges. Ancient Indian granaries on the Green River above Hell Roaring Canyon (2089); in Cataract Canyon below Mile Rapids, abundant at Dark Canyon (2130A); aboundant throughout Glen Canyon; Marble Canyon at President Harding Rapids (2280); in Grand Canyon common on Kaibab Trail of the South Rim, Tanner Rapids, common at Hermit Rapids, Havasupai Canyon, mouth of Diamond Creek (2292), and Separation Rapids; common on dry canyon walls in Spencer Canyon (4197); Boulder Dock (4168). On talus the entire length of Lake Mead.

Cyperaceae

Carex subfusca Boott. Two miles above Emory Falls on Lake Mead (4292).

Carex Thurberi Dewey. Mouth of Bright Angel Creek (4100).

Cladium Mariscus var. *californicum* S. Wats. This is a tropical and subtropical species. Tidestrom reports it from southern Nevada. Lava Falls (2372); two miles above Emory Falls on Lake Mead (4292).

Cyperus erythrorhizos Muhl. Below Mile Rapids in Cataract Canyon (2126A); Separation Rapids (4236).

Eleocharis calva Torr. Graham reports a collection by Hermann (in 1933) on the south slope of the Uinta Mountains as the first from Utah, representing a westward extension of the range. Mile Rapids in Cataract Canyon (2128A); and at Lava Falls (2364).

Eleocharis rostellata Torr. Lava Falls (2366) (2369).

Scirpus americanus Pers. Greenriver (1960).

Scirpus Olneyi A. Gray. Lava Falls (2362) (2368).

Scirpus paludosus A. Nels. Mile Rapids in Cataract Canyon (2119A).

Juncus Dudleyi Wieg. Mouth of Bright Angel Creek (4095). Graham reports this species from Vernal, Utah.

Juncus saximontanus A. Nels. Mouth of Bright Angel Creek (4091).

Juncus Torryi Cov. Graham has collected a single specimen near Vernal, Utah, but our first collection was no farther north than Rainbow Bridge (4052). Mouth of Bright Angel Creek (4090); Separation Canyon, common (4237).

Liliaceae

Calochortus Nuttallii Torr. and Gray. Outside the canyon south of Moab (1989).

Nolina microcarpa S. Wats. Elves' Chasm (2330); Havasupai Canyon; two miles below Kanab Canyon.

Yucca angustissima Engelm. Common below mouth of Clearwater Canyon in Cataract Canyon; Bridge Canyon and Surprise Valley; mouth of Moki Creek in Glen Canyon; in Marble Canyon at Mile 26½ (2218), and at Vasey's Paradise (2255); Hualapai Canyon; on top of Supai Formation in Havasupai Canyon (5199).

Yucca baccata Torr. Outside the canyon south of Montecello (2023); on top of the Supai Formation in Havasupai Canyon (5288).

Yucca Harrimaniae Trelease. Outside the canyon between Greenriver and Moab (1974), and south of Moab (1991); Mile 26 on the Green River (2099); below the Mile Rapids in Cataract Canyon (2118); occasional in Grand Canyon.

Yucca Whipplei Torr. Spencer Canyon (4263); ten miles above Emory Falls on Lake Mead (5278).

Amaryllidaceae

Agave utahensis Engelm. In Marble Canyon at Mile 26½ (2213) (2215) (2216) (2217), at Mile 19, and at Mile 39; in Grand Canyon at Saddle Canyon, Hermit Creek Rapids, and near mouth of Havasupai Canyon and Separation Rapids. Fairly common from Marble Canyon to Lake Mead.

Orchidaceae

Epipactis gigantea Dougl. Rainbow Bridge (4033A); Havasupai Canyon below Mooney Falls; Conquistadore Aisle in Grand Canyon (2323); two miles above Emory Falls on Lake Mead (4298).

Salicaceae

Populus arizonica Sarg. Havasupai Canyon (2352).

Populus Fremontii S. Wats. Near Yokey's Flat on the Green River (2086); in Glen Canyon at Hite Ranch, Ticaboo Creek, mouth of the Escalante River, and Bridge Canyon; Havasupai Canyon.

Populus italica DuRoi. Havasupai Canyon [Col. for Clover by Lorenzo and Harriet Sinyella (23)].

Salix amygdaloides Andersson. Greenriver (1931) (1940A);

Salix exigua Nutt. On the Green River at Mile 84 (2042), and mouth of Hell Roaring Canyon (2070); above Dark Canyon (2175); in Glen Canyon at Hite Ranch, mouth of Ticaboo Creek, California Bar, mouth of Moki Creek, Warm Springs Creek, and Bridge Canyon; along river at Lee's Ferry (2190); in Grand Canyon at Deer Creek Falls (2338), Lava Falls (2365A), and Mile 192 (2385).

Salix Gooddingii Ball. Common at Lee's Ferry (2194); Mile 192 in Grand Canyon (2379).

Salix laevigata Bebb var. *araquipa* (Jeps.) Ball. Common in Havasupai Canyon (4432) [Col. for Clover by Sinyella (12)].

Juglandaceae

Juglans rupestris var. *major* Torr. Havasupai Canyon (4406). Rare.

Fagaceae

Quercus Gambelii Nutt. (Fig. 6 A) At Red Creek near the mouth of the Dirty Devil River (2185A); in Glen Canyon at Mouth of Moki Canyon, California Bar, Klondike Bar, mouth of Lake Canyon at Mile 113 (2186A); Surprise Valley (4005) (4008) (4016) (4017); South Rim in first half mile near Kaibab Trail (4113), North Rim at Port Royal (4358).

Quercus turbinella Greene. Surprise Valley (4010); Hualapai Canyon; Grapevine Springs in Havasupai Canyon.

Ulmaceae

Celtis reticulata Torr. Cataract Canyon at Mile Rapids (2120A), one mile south of Clear water Canyon, Mile 184½, and mouth of Dark Canyon; in Glen Canyon near mouth of Sevenmile Creek, Mile 104, Bridge Canyon, and nine miles above Lee's Ferry; in Marble Canyon at Mile 19 and Saddle Canyon; in Grand Canyon at Elves' Chasm, two miles below the mouth of Kanab Canyon, Havasupai Canyon, Lava Falls, and Mile 192.

Urticaceae

Parietaria pennsylvanica Muhl. Navajo (Bridal Veil) Falls in Havasupai Canyon (4410).

Urtica holosericea Nutt. Deer Creek Falls in Grand Canyon (2243).

Loranthaceae

Phoradendron californicum Nutt. On *Acacia* in Cataract Canyon above Mile 192 of the Grand Canyon (2376); on mesquite at Mile 192 (2381); on mesquite at 217 Mile Canyon in Grand Canyon (2394) (2395), Spencer Canyon.

Santalaceae

Comandra pallida A. DC. Surprise Valley (4009).

Polygonaceae

Chorizanthe rigida (Torr.) Torr. & Gray. Abundant near Boulder Dock (4169).

Eriogonum aureum M. E. Jones. Bridge Canyon (4039); fairly common at Port Royal on North Rim. (4304) (4314).

Eriogonum deflexum Torr. Common at Lee's Ferry (2188) (4337); common with *E. inflatum* at Boulder Dock (4188).

Eriogonum fasciculatum Benth.? Infrequent at mouth of Spencer Canyon (4253); near Boulder Dock (4185).

Eriogonum inflatum Torr. & Frem. Greenriver (1943) and Mile 84 on the Green River (2041); in Cataract Canyon at Rapids 13 (2123A), and infrequent at mouth of Dark Canyon (2163); Surprise Valley; Lee's Ferry (4338); President Harding Rapids in Marble Canyon; Boulder Dock (4170) (4187). Occasional to common throughout the canyon.

Eriogonum ovalifolium Nutt. var. *purpureum* Stokes. Outside the canyon between Moab and Montecello (1999).

Eriogonum Simpsoni Benth. South Rim below the Coconino sandstone near the Kaibab Trail (4123) (4124).

Eriogonum Wetherillii Eastw. Lee's Ferry (4339).

Polygonum aviculare L. Havasupai Canyon (4385).

Polygonum buxiforme Small. Havasupai Canyon (4392).

Rumex crispus L. South Rim below the Coconino sandstone near the Kaibab Trail (4117); above village in Havasupai Canyon (4319).

Rumex Patientia L. Outside the canyon south of Moab (1993).

Chenopodiaceae

Atriplex canescens (Pursh) Nutt. Outside the canyon east of Greenriver (1965); common from Greenriver (1929) to Mile 84 (2032) (2027) (2035) (2038), site of Julian's name (2060), and mouth of Hell Roaring Canyon (2077); in Cataract Canyon below Mile Rapids (2112A), abundant at Rapids 13 (2123) (2128) (2132A), and at mouth of Dark Canyon (2148A); in Glen Canyon at Forbidding Canyon (4061), and mouth of Moki Canyon; at Lee's Ferry (2186B) (4346) (4347); in Marble Canyon at Mile 19, President Harding Rapids, and from Saddle Canyon to mouth of Bright Angel Creek; South Rim near the Kaibab Trail in first half mile (4128), and fourth half mile (4153); common at Port Royal on North Rim (4312); common throughout Hualapai and Havasupai Canyons (4368); Separation Canyon; between mouth of Quartermaster Canyon and Upper Travertine Springs; two miles above Emory Falls on Lake Mead (4281).

Atriplex hymenelytra (Torr.) S. Wats. Two miles above Emory Falls on Lake Mead (4291). Apparently new to Mojave Co., Ariz.

Atriplex Jonesii Standl. Greenriver (1937); Lee's Ferry (4340) (4355).

Atriplex Nuttallii S. Wats. Outside the canyon on flats east of Greenriver (1966A).

Atriplex rosea L. Near the Kaibab Trail in third half mile below the South Rim (4148).

Chenopodium album L. Mile 84 on the Green River (2028).

Corispermum nitidum Kit. Separation Rapids (4211).

Echinopsilon hyssopifolius (Pall.) Moq. Common at Separation Rapids (4209).

Eurotia lanata (Pursh) Moq. Greenriver (1957); mouth of Hell Roaring Canyon (2094).

Salsola Kali L. var. *tenuifolia* Tausch. (*S. pestifer* A. Nels.) Outside the canyon at Montecello (2020A); Greenriver (1924); common in Cataract Canyon at Rapids 13 (2131A), and at mouth of Dark Canyon (2165); in Glen Canyon at mouth of Moki Canyon; Lee's Ferry (4351); common in stream bed at Separation Canyon (4212); near Boulder Dock (4182) (4184).

Sarcobatus vermiculatus (Hook.) Torr. Greenriver (1915); common at Mile 84 on the Green River (2023A), and abundant at mouth of Hell Roaring Canyon (2074) (2078A).

Suaeda Torreyana S. Wats. Greenriver (1924); mouth of Hell Roaring Canyon (2075), Tanner Rapids in the Grand Canyon (2291A).

Amaranthaceae

Amaranthus blitoides S. Wats. Navajo (Bridal Veil) Falls in Havasupai Canyon (4408A); upper Lake Mead in Quartermaster Canyon (4271A) (4272A).

Amaranthus hybridus L., (Immature). Common near creek throughout Havasupai Canyon (4405A).

Amaranthus Powellii S. Wats. Common near creek in Havasupai Canyon (4406A).

Tidestromia oblongifolia (S. Wats.) Standl. Mouth of Diamond Creek (2391); mouth of Separation Canyon (4231) (4239); two miles above Emory Falls (4285).

Nyctaginaceae

Abronia glabra. Rydb. Ooutside the canyon between Moab and Montecello (2006).

Abronia fallax Heimerl. Outside the canyon between Moab and Montecello (2010).

Abronia pumila Rydb. Infrequent at Mile 84 on the Green River (2025).

Allionia incarnata L. In Marble Canyon at President Harding Rapids (2286); in Grand Canyon at Tanner Rapids (2293)?; Havasupai Canyon (4420).

Allionia linearis Pursh. Greenriver (1948), and Mile 84 on the Green River (2029A); Cataract Canyon at Rapids 13 (2133).

Boerhaavia Torreyana (S. Wats.) Standl. Above village in Havasupai Canyon (4386).

Mirabilis Bigelovii A. Gray. Spencer Canyon (4250).

Mirabilis multiflora (Torr.) A. Gray. Kaibab Trail, second half mile from the South Rim (4141); Grand Canyon at Conquistadore Aisle (2332).

Tripterocalyx pedunculatus (M. E. Jones) Standl. Outside the canyon south of Moab (1983); Greenriver (1919) and fairly common at Mile 84 (2033); Cataract Canyon below Rapids 7 (2108).

Aizoaceae

Sesuvium sessile Pers. On the Green River near Yokey's Flat (2091).

Ranunculaceae

Aquilegia chrysantha A. Gray. Near spring at mouth of Dark Canyon (2139); at spring, Rainbow Bridge (4030); two miles above Emory Falls (4296) (4196), and at Emory Falls (4191).

Clematis ligusticifolia Nutt. Bridge Canyon (4040); abundant near spring in Havasupai Canyon (4405).

Berberidaceae

Berberis Fremontii Torr. Outside the canyon between Moab and Montecello (1997).

Papaveraceae

Argemone platyceras Link & Otto. Cataract Canyon at Rapids 13 (2136A).

Cruciferae

Arabis perennans S. Wats.? Marble Canyon at Mile 16½ (2204), and Mile 26½ (2224).

Descurainia pinnata (Walt.) Britton subsp. *glabra* (Woot. and Standl.) Detling. Common throughout the upper part of Havasupai Canyon [Col. for Clover by Sinyella (2)].

Lepidium Eastwoodiae Wooton. Greenriver (1918).

Lepidium Jonesii Rydb. Outside the canyon between Moab and Montecello (2000) (2014); Greenriver (1952), and at the site of Julian's name on the Green River (2055) (2056); Cataract Canyon below Mile Rapids (2117). Common at Lee's Ferry (2197).

Lepidium montanum Nutt. (Probably var. *glabrum* C. L. Hitchcock). On Kaibab limestone, South Rim (4119).

Rorippa Nasturtium-aquaticum (L.) Shinz & Thell. Marble Canyon at Vasey's Paradise (2245); Grand Canyon at Hermit Rapids (2296A), and very abundant in Havasupai Canyon (4376).

Stanleya pinnata (Pursh) Britton. Outside the canyon at Montecello (2018); from Greenriver to the confluence of the Green and the Colorado Rivers, Mile 26 (2097); in Cataract Canyon below Rapids 7 (2106), infrequent below Mile Rapids (2122), and mouth of Dark Canyon (2177); near Kaibab Trail in the third half mile below the South Rim (4143); near Navajo (Bridal Veil) Falls in Havasupai Canyon (4409).

Thelypodium integrifolium (Nutt.) Endl. South Rim near Kaibab Trail (4115); Havasupai Canyon one mile above village (4364) and common throughout the canyon (4408); on Lake Mead two miles above Emory Falls (4284).

Thelypodium rhomboideum Greene. One mile above village in Havasupai Canyon (4379).

Capparidaceae

Cleome lutea Hook. Greenriver (1914) (1914A); mouth of Forbidding Canyon (4076) (4076A); Havasupai Canyon (4381) (4395).

Wislizenia refracta Engelm. Mouth of Separation Canyon (4217).

Saxifragaceae

Fendlera rupicola A. Gray. South Rim near Kaibab Trail, third half mile (4139), and fourth half mile (4161).

Ribes inebrians Lindl. Port Royal on North Rim (4311).

Ribes velutinum Greene. Port Royal on the North Rim (4316).

Rosaceae

Amelanchier utahensis Koehne. North Rim at Port Royal (4306); South Rim below the Coconino sandstone (4126); on trail to Supai down Hualapai Canyon.

Cercocarpus intricatus S. Wats. var. *villosus* C. K. Schneid. Common on the upper Kaibab Trail, South Rim (4160); North Rim at Port Royal (4315).

Chamaebatiaria Millefolium (Torr.) Maxim. South Rim on Coconino sandstone near the Kaibab Trail (4109); North Rim at Port Royal (4307).

Coleogyne ramosissima Torr. Outside the canyon between Greenriver and Moab (1973); between Navajo Mt. and Rainbow Bridge, and Surprise Valley (4029); on trail to Supai down Hualapai Canyon.

Cowania Stansburiana Torr. Between Rainbow Bridge and Navajo Mt., Surprise Valley, and abundant in Bridge Canyon (4050A); abundant in Marble Canyon at Mile 39, Saddle Canyon, and Vasey's Paradise (2262). Not seen for some distance

immediately above Vasey's Paradise. In Grand Canyon at Hermit Rapids (2303A), and common on both rims of the Grand Canyon.

Fallugia paradoxa (Don.) Endl. Common at Mile 26½ in Marble Canyon (2225).

Petrophytum caespitosum (Nutt.) Rydb. Mouth of Hell Roaring Canyon (2083A).

Prunus fasciculata (Torr.) A. Gray. In Grand Canyon from Saddle Canyon to Bright Angel Crossing, at Tanner Rapids (2298), and at Hermit Rapids (2298A) (2299A).

Purpusia arizonica Eastw. North Rim at Port Royal (4328).

Rosa oreophila Rydb. Outside the canyon at Montecello (2021).

Leguminosae

Acacia Greggii A. Gray. First seen forty miles below Lee's Ferry in Marble Canyon; common at President Harding Rapids (2285); common from Saddle Canyon at Mile 47 to Bright Angel Crossing; Elves' Chasm; Conquistadore Aisle; mouth of Kanab Canyon; near Upset Rapids; Havasupai and Hualapai Canyons; Lava Falls; Hurricane Fault; common at Mile 189 & Mile 193; Diamond Creek; luxuriant growth in Separation Canyon (4225); abundant in Spencer Canyon; mouth of Surprise Canyon; abundant between Quartermaster Canyon and Travertine Springs in seeps from base of Mauv limestone below the Bright Angel shale; two miles above Emory Falls and at Emory Falls; occasional in Virgin Canyon.

Amorpha fruticosa L. var. *occidentalis* (Abrams) Kearney & Peebles. Grand Canyon at Deer Creek Falls, very commcn in seepage areas down stream from the falls (2340).

Astragalus ceramicus Sheldon var. *imperfectus* Sheldon. Outside the canyon between Montecello and Moab (2001).

Astragalus Preussii A. Gray. Abundant at mouth of Dark Canyon (2142).

Astragalus Thompsonae S. Wats. Greenriver (1939A), and in Gray Canyon at Mile 84 (2046); Cataract Canyon below Rapids 7 (2105A).

Cassia Covesii A. Gray. Lake Mead along stream at Quartermaster Canyon (4273A).

Cercis occidentalis Torr. Abundant at mouth of Dark Canyon (2168); in Glen Canyon below the California Bar, and at Rainbow Bridge (4053); infrequent in Marble Canyon, one tree at Mile 19, a few small trees at Mile 26½, several at Mile 39, and at Vasey's Paradise; at foot of Kanab Trail, and two miles below Kanab Canyon; Havasupai Canyon.

Dalea amoena S. Wats. *Surprise Valley* (4025).

Dalea sp. Infrequent at Conquistadore Aisle in Grand Canyon (2325).

Glycyrrhiza lepidota (Nutt.) Pursh. Greenriver (1933), Mile 84 (2048), and at site of Julian's name on the Green River (2051); Lee's Ferry (2200).

Krameria parvifolia Benth. var. *imparata* Macbr. In Grand Canyon at Mile 193 (2383), common at Diamond Creek (2389), and at Boulder Dock (4173A) (4189).

Krameria parvifolia Benth. var. *glandulosa* (Rose & Painter) Macbr. Boulder Dock (4173).

Lupinus barbiger S. Wats. Outside the canyon near Montecello (2019).

Melilotus alba Desr. Greenriver (1938); two miles above Dark Canyon (2173); common at Lee's Ferry (2193); Havasupai Canyon (4383).

Melilotus indica (L.) All. Mouth of Havasupai Canyon (2355).

Parryella filifolia Torr. & Gray. Lee's Ferry (4356).

Petalostemon flavescens S. Wats. Surprise Valley (4021), and in Bridge Canyon (4044).

Prosopis juliflora (Swartz) DC. var. *glandulosa* (Torr.) Cockerell. In Marble Canyon abundant on Red Wall limestone talus at Mile 39, at President Harding Rapids (2284), and from Saddle Canyon to Bright Angel crossing; on the trail through Hualapai Canyon to Supai, and in Havasupai Canyon (4369); in Grand Canyon below

Lava Falls at Mile 193 (2380), at mouth of Diamond Creek, 217 Mile Canyon (2395A), Separation Canyon (4226), Spencer Canyon; between Quartermaster Canyon and Upper Travertine Springs, and two miles above Emory Falls.

Psoralea micrantha A. Gray. On the Green River at Mile 26 (2089A).

Vicia americana Muhl. Outside the canyon near Montecello (2018B).

Linaceae

Linum Lewisii Pursh. South Rim near the third half mile of the Kaibab Trail (4145).

Zygophyllaceae

Larrea glutinosa Engelm. Lava Falls (2373), Hurricane Fault, Mile 189, mouth of Diamond Creek, Separation Canyon (4228), and Spencer Canyon; frequently dominant along Lake Mead, Quartermaster Canyon and Upper Travertine Springs, two miles above Emory Falls, at Surprise Canyon, below Virgin Canyon, and Boulder Dock (4172).

Rutaceae

Ptelea Baldwinii Torr. & Gray. South Rim near the Kaibab Trail, second half mile (4137), third half mile (4152), and fourth half mile (4154) (4162); on Kaibab limestone in Havasupai Canyon.

Thamnosma montana Torr. & Frem. In Grand Canyon at Granite Rapids on ledges and talus (2287A), and in Havasupai Canyon.

Euphorbiaceae

Bernardia incana Morton. Grand Canyon at Hermit Rapids (2315).

Ditaxis neomexicana (Muell. Arg.) Heller. Separation Canyon (4222), and Spencer Canyon (4251).

Euphorbia bilobata Engelm. Mile 16½ in Marble Canyon (2206).

Euphorbia Fendleri Torr. & Gray. South of Moab (1981; common on North Rim at Port Royal (4310).

Euphorbia glyptosperma Engelm. Floor of Forbidding Canyon (4058);

Euphorbia polycarpa Benth. Abundant near Boulder Dock (4175).

Euphorbia polycarpa Benth. var. *hirtella* Boiss. Abundant near Boulder Dock (4174) (4176).

Anacardiaceae

Rhus radicans L. Common at Vasey's Paradise.

Rhus trilobata Nutt. Common from Greenriver (1935) to Mile 84 (2021) (2068), and mouth of Hell Roaring Canyon (2084); Cataract Canyon at Rapids 1; Narrow Canyon near the mouth of the Dirty Devil River; Surprise Valley (4018). Hualapai and Havasupai Canyons.

Rhus trilobata Nutt. var. *simplicifolia* (Greene) Munz & Sloane. Dark Canyon (2170); Rainbow Bridge (4048); South Rim, fourth half mile near the Kaibab Trail (4156); Hualapai Canyon on the trail to Supai.

Rhus utahensis Goodding. Five miles above the confluence of the Green and Colorado Rivers (2103); second half mile below the South Rim near the Kaibab Trail (4138).

Celastraceae

Mortonia scabrella A. Gray var. *utahensis* Cov. On upper talus slopes, Havasupai Canyon. (5149).

Aceraceae

Acer interius Torr. Abundant across from Music Temple in Glen Canyon; In Havasupai Canyon abundant on canyon floor above Navajo Falls, associated with *Fraxinus velutina* (5210).

Rhamnaceae

Condalia lycioides (A. Gray) Weberb. *canescens* (A. Gray) Trelease. Cataract Canyon at Rapids 13 (2121); Surprise Valley and Rainbow Bridge; on trail to Supai

down Hualapai Canyon; Havasupai Canyon (4370); and at the junction of Havasupai Canyon with the Colorado (2357).

Rhamnus betulaefolia Greene. Mouth of Dark Canyon (2154); Surprise Valley.

Rhamnus betulaefolia Greene var. *obovata* Kearney & Peebles. South Rim in second half mile near the Kaibab Trail (4135).

Vitaceae

Parthenocissus vitacea (Knerr) Hitchc. Bridge Canyon; Havasupai Canyon (4388).

Vitis arizonica Engelm. Mouth of Havasupai Canyon (2347), and abundant along stream between village and the Colorado; in Grand Canyon at Mile 193; abundant two miles above Emory Falls on Lake Mead (4294).

Malvaceae

Sida hederacea (Dougl.) Torr. Mouth of Hell Roaring Canyon (2093).

Sphaeralcea ambigua A. Gray. Very common at Spencer Canyon (4260).

Sphaeralcea coccinea (Pursh) Rydb. Outside the canyon south of Moab (1984).

Sphaeralcea Fendleri A. Gray. Mouth of Dark Canyon (2161).

Sphaeralcea grossulariaefolia (Hook & Arn.) Rydb. Infrequent at Mile 84 on the Green River (2030); common at President Harding Rapids in Marble Canyon (2275).

Sphaeralcea grossulariaefolia (Hook & Arn.) Rydb. var. *pedata* (Torr.) Kearney. Havasupai Canyon (4361) (4380); mouth of Separation Canyon (4207) (4227).

Sphaeralcea parvifolia A. Nels. Roadside east of Greenriver (1967), Greenriver (1963), and common at Mile 84 from Greenriver (2031); common in Havasupai Canyon (4375).

Sphaeralcea Rusbyi A. Gray. Surprise Valley (4013).

Tamaricaceae

Tamarix gallica L. Greenriver (1925) to the confluence of the Green and the Colorado Rivers; common at Dark Canyon (2143) and south of Clearwater Canyon; in Glen Canyon common below the California Bar, occasional near Rainbow Bridge; above Lee's Ferry, and at Lee's Ferry (2191A); absent in Marble Canyon except below Vasey's Paradise and at mouth of Saddle Canyon; in the lower Grand Canyon at Lava Pinnacle (two miles above Lava Falls); Separation Rapids (4204). Introduced.

Fouquieriaceae

Fouquieria splendens Engelm. First seen three miles above the mouth of Havasupai Canyon on upper walls from Mauv limestone to the Kaibab limestone; on talus at Fern Glen Rapids; abundant at Red Slide Canyon; two miles below Lava Falls; at Hurricane Fault three miles below Lava Falls; high on ledges at Mile 192 and Mile 193; at the mouth of Diamond Creek; Separation Rapids; Quartermaster Canyon; Waterfall Canyon; Upper Travertine Springs; Emory Falls to Pierce Ferry on Lake Mead.

Cactaceae

Echinocactus polycephalus Engelm. & Bigelow. On trail to Supai down Hualapai Canyon; steep talus in Spencer Canyon (4447) (Mich. Bot. Gard. no. 17160); abundant two miles above Emory Falls on Lake Mead.

Echinocereus acifer (Otto) Lemaire? Mouth of the Dirty Devil River (2184).

Echinocereus canyonensis Clover & Jotter. Grand Canyon two miles above Bass Cable (2317) same as Mich. Bot. Gard. no. 16846). Occasional.

Echinocereus coccineus Engelm. Mouth of the Dirty Devil River (2186); Havasupai Canyon (Mich Bot. Gard. no. 17168) (17170).

Echinocereus decumbens Clover & Jotter. Marble Canyon at Mile 26½ (2212) same as (Mich. Bot. Gard. no. 16870). Rare.

Echinocereus Engelmannii (Parry) Rümpler. Glen Canyon along the Mormon Trail,

Lee's Ferry; in Marble Canyon abundant at President Harding Rapids (2273A), at Kwagunt Rapids and abundant at Nankoweap Rapids; mouth of Bright Angel Creek; abundant at Port Royal on the North Rim (4334); very abundant at Hermit Creek Rapids; Elves Chasm; in Havasupai and Hualapai Canyons; below Lava Falls at Mile 193; 205 Mile Canyon above Diamond Creek; on Lake Mead in Surprise Canyon and two miles above Emory Falls.

Echinocereus Fendleri (Engelm.) Rümpler. In Marble Canyon at Mile 26½, Vasey's Paradise, and President Harding Rapids (2281); mouth of Bright Angel Creek; Hermit Rapids; Elves' Chasm; mouth of Havasupai Canyon; Granite Rapids.

Echinocereus mojavensis (Engelm. & Bigelow) Rümpler. Below Rapids 7 in Cataract Canyon (2112).

Echinocereus octacanthus (Mühlenpfordt) Britt. & Rose. At the mouth of the Dirty Devil River (2184A), Surprise Valley between Navajo Mt. and Rainbow Bridge; in Marble Canyon at Vasey's Paradise; mouth of Bright Angel Creek; Hermit Rapids (2303); two miles above Bass Cable (2317A); and Elves's Chasm.

Ferocactus acanthodes (Lemaire) Britt. & Rose. In Marble Canyon at Mile 26½ (2239), small plants at Vasey's Paradise (2271), rare at President Harding Rapids (2272), and occasional between Saddle Canyon and Bright Angel Crossing; in Grand Canyon at Hermit Rapids, at Walthenburg Rapids plants 2–5 feet high, Elves' Chasm, mouth of Havasupai Canyon (4444), Lava Falls (2371), Hurricane Fault, Mile 193, Diamond Creek, Separation Rapids (4443) (4254), Spencer Canyon; Surprise Canyon, small plants; abundant and vigorous between Quartermaster Canyon and Emory Falls; in Virgin Canyon abundant but small and often unhealthy.

Echinomastus Johnsonii Parry. Infrequent at foot of Navajo Mt.; some dead specimens at Boulder Dock; very abundant south of Pierce Ferry.

Opuntia acanthocarpa Engelm. & Bigelow. Hualapai Canyon; Lava Falls; Diamond Creek (2396); Quartermaster Canyon (4276) (4277); Surprise Canyon; mouth of Virgin Canyon; Boulder Dock (4180).

Opuntia aurea Baxter. Fourth half mile below South Rim near the Kaibab Trail (4165).

Opuntia basilaris Engelm. & Bigelow. In Cataract Canyon, rare ½ mile south of Clearwater Canyon; in Marble Canyon at Mile 26½, Mile 39, President Harding Rapids, and from Saddle Canyon to Bright Angel Creek; in Grand Canyon at Elves' Chasm, Mile 193, and 205 Mile Canyon above Diamond Creek, fairly abundant at Spencer Canyon (4440), Separation Rapids; two miles above Emory Falls, Boulder Dock.

Opuntia basilaris Engelm. var. *nana* Hort.? Separation Canyon (4248).

Opuntia Bigelovii Engelm. Mile 193 below Lava Falls (2388); Diamond Creek; Spencer Canyon (4257).

Opuntia brachyclada Griffiths. Cataract Canyon along Mile Rapids (2111); Forbidding Canyon (2403).

Opuntia chlorotica Engelm. & Bigelow. Lee's Ferry (4335); on canyon floor of Hualapai Canyon; abundant in Havasupai Canyon (4441) (Mich. Bot. Gard. no. 17166); Mile 142 in Grand Canyon.

Opuntia echinocarpa Engelm. & Bigelow. Mouth of Spencer Canyon (4450).

Opuntia Engelmannii Salm-Dyck. In Marble Canyon at President Harding Rapids, Kwagunt Rapids, and from Saddle Canyon to Bright Angel Creek; above Bass Trail (2316); Elves' Chasm; abundant at Granite Rapids; on the walls of Havasupai Canyon (4449) (4439).

Opuntia erinacea Engelm. & Bigelow. Mouth of Forbidding Canyon (2399), and between Navajo Mt. and Rainbow Bridge; abundant in Havasupai and in Hualapai Canyons.

Opuntia humistrata Griffiths? Port Royal on the North Rim (4331).

Opuntia hystricina Engelm. & Bigelow. Hell Roaring Canyon (2081); mouth of Forbidding Canyon (2401); Lee's Ferry (4333); near Bright Angel Creek; Port

Royal on the North Rim (4332) (4333); Nankoweap; mouth of Havasupai Canyon.

Opuntia laevis Coulter. Hermit Rapids (2301B).

Opuntia longiareolata Clover & Jotter. Granite Falls (2302) same as (Mich. Bot. Gard. no. 16852). Rare.

Opuntia mojavensis Engelm. & Bigelow. Fairly common in Havasupai Canyon on Red Wall limestone (4438) (Mich. Bot. Gard. no. 17169).

Opuntia molesta Brandegee. Diamond Creek (2397).

Opuntia phaeacantha Engelm. Abundant at President Harding Rapids (2273); Nankoweap; near the Kaibab Trail in fourth half mile from the South Rim (4167).

Opuntia polyacantha Haworth. Outside the canyon between Moab and Montecello (1990) (2016); on the Green River at Mile 84; in Glen Canyon at Mile 142, above Moki Canyon, where a robust form and a normal one were seen; same robust form at Surprise Valley and Bridge Canyon; Lee's ferry; in Marble Canyon at President Harding Rapids; in Grand Canyon at Tanner Rapids, Kwagunt Rapids in association with *O. Engelmannii* and *Echinocereus Engelmnnii* (2300), Nankoweap Rapids, and Hermit Rapids (2302A).

Opuntia rhodantha K. Schum. On the Green River near Yokey's Flat (2082) (2100), mouth of Hell Roaring Canyon (2078) (2079); Port Royal on the North Rim (4330); two miles above Emory Falls (4300).

Opuntia tetracantha Toumey. Mouth of Diamond Creek (2402).

Opuntia Vaseyi (Coulter) Britt. & Rose. In the Rainbow Bridge Area at Surprise Valley; floor of Hualapai Canyon; Grand Canyon two miles above Bass Cable (2318).

Opuntia Whipplei Engelm. & Bigelow. Marble Canyon at Vasey's Paradise; in Grand Canyon at Upset Rapids, Walthenburg Rapids (2319), on Kibab limestone in Hualapai Canyon (4437), mouth of Havasupai Canyon, Lava Falls, and Diamond Creek.

Phellosperma tetrancistra (Engelm.) Britt. & Rose. Fairly abundant from mouth of Forbidding Canyon (2400) to Pierce Ferry on Lake Mead; in Marble Canyon at Mile 26½ (2240), Vasey's Paradise, and abundant from Saddle Canyon to Bright Angel Creek; in Grand Canyon at Granite Rapids, Hermit Rapids, two miles above Bass Cable, Elves' Chasm, Havasupai Canyon (4442), Diamond Creek, abundant at Separation Canyon (4247), Spencer Canyon; two miles above Emory Falls on Lake Mead (4287).

Sclerocactus parviflorus Clover & Jotter. In Glen Canyon common from Mile 142, the mouth of Moki Canyon, to the mouth of Forbidding Canyon (2398) same as Mich. Bot. Gard. no 16845); fairly common along lower San Juan River; Hualapai and Havasupai Canyons.

Sclerocactus polyancistrus (Engelm. & Bigelow) Britt. & Rose. Cataract Canyon below Mile Rapids (2113); between Navajo Mt. and Rainbow Bridge (mostly dead); Surprise Valley; Bridge Canyon.

Sclerocactus Whipplei (Engelm. & Bigelow) Britt. & Rose. On the Green River at Mile 84.

Loasaceae

Eucnide urens Parry. Occasional at Separation Canyon (4238).

Mentzelia albicaulis Dougl. Green River (1942) (1953).

Mentzelia integra (Jones) Tidestrom. Third half mile below South Rim near Kaibab Trail (4151).

Mentzelia pumila (Nutt.) Torr. and Gray. Mouth of Dark Canyon (2153).

Mentzelia pumila var. *multiflora* (Nutt.) Urb. & Gilg. Green River (1941); Dark Canyon (2153); Rainbow Bridge (4050).

Petalonyx Thurberi A. Gray. Fairly Common near Boulder Dock (4181).

Elaeagnaceae

Shepherdia rotundifolia Parry. Frequent on rocky slopes along the Green River

in Labyrinth Canyon, Mile 84 (2052); Rainbow Bridge; Port Royal on the North Rim (4305).

Onagraceae

Gaura parviflora Dougl. On the Green River at Mile 84 (2044A).

Oenothera longissima Rydb. Mouth of Dark Canyon (2147A).

Oenothera micrantha Hornem. var. *exfoliata* (A. Nels.) Munz. Grand Canyon at Conquistadore Aisle (2327); Havasupai Canyon (4384).

Oenothera multijuga S. Wats. Marble Canyon at President Harding Rapids (2274); Grand Canyon at the mouth of Havasupai Canyon; Lake Mead two miles above Emory Falls (4283) (2348).

Oenothera multijuga S. Wats. var. *orientalis* Munz. Marble Canyon at Mile 16½ (2208).

Oenothera multijuga S. Wats. var. *parviflora* (S. Wats.) Munz. Frequent in Separation Canyon (4232), and below Spencer Canyon (4268).

Umbelliferae

Apium graveolens L. Havasupai Canyon, abundant near Navajo (Bridal Veil) Falls (4418).

Lomatium Parryi (S. Wats.) Macbride. Surprise Valley (4006).

Primulaceae

Primula specuicola Rydb. Abundant on walls near Emory Falls on Lake Mead (4194). High on walls Colorado Canyon, southern Utah and Arizona.

Oleaceae

Forestiera neomexicana A. Gray. Mouth of Hell Roaring Canyon (2072); Cataract Canyon above Rapids 1 (2104).

Fraxinus anomala Torr. Outside the canyon, on roadside north of Moab (1975); on the Green River five miles above its confluence with the Colorado (2102); Cataract Canyon at Rapids 13 (2132), and mouth of Dark Canyon (2166) (2167); Rainbow Bridge (4056); abundant in Surprise Valley (4026), Bridge Canyon, and Forbidding Canyon (4079); South Rim in second half mile near the Kaibab Trail (4142); Hualapai Canyon.

Fraxinus Lowellii Sarg. Single small tree at mouth of Havasupai Canyon (2346).

Fraxinus velutina Torr. var. *glabra* (Thornber) Rehder. Common throughout Havasupai Canyon (4423A); on Lake Mead, two miles above Emory Falls (4478). Trees 35 feet in height and 7 inches in diameter, growing in seep at base of the dolomite of the Bright Angel Shale.

Gentianaceae

Centaurium calycosum (Buckl.) Fern. Rare, growing on coarse gravel near mouth of Bright Angel Creek (4087).

Frasera speciosa Dougl. North Rim at Port Royal (4360).

Frasera utahensis Jones. Forbidding Canyon (4077A); Hualapai Canyon.

Apocynaceae

Amsonia Eastwoodiana Rydb. Lee's Ferry on boulder strewn shore (4352).

Apocynum cannabinum L. On the Green River at Mile 84 (2044); mouth of Dark Canyon (2156); Bridge Canyon, and Surprise Valley; Marble Canyon at Mile 16½ (2205); Deer Creek Falls (2344); Havasupai Canyon.

Apocynum Sukdorfii Greene var. *angustifolium* (Woot.) Woodson. Common along river at Lee's Ferry (2189).

Asclepiadaceae

Asclepias latifolia (Torr.) Raf. Cataract Canyon at Rapids 7 (2114).

Asclepias labriformis M. E. Jones. Surprise Valley (4023).

Asclepias galioides H. B. K. On the Green River at site of Julian's name (2054), and mouth of Hell Roaring Canyon (2071); mouth of Dark Canyon (2140); Surprise Valley (4027).

Funastrum cynanchoides (Decaisne) Schlechter. Forbidding canyon (4075).

Convolvulaceae

Cuscuta denticulata Engelm. Parasitic on *Larrea* near boat dock at Boulder City (4177). Second record for Arizona.

Polemoniaceae

Gilia arizonica (Greene) Rydb. Floor of Forbidding Canyon (4069A), and in Surprise Valley (4011).

Gilia Gunnisonii Torr. & Gray. Greenriver (1946).

Gilia longiflora (Torr.) G. Don. Outside the canyon between Moab and Montecello (2015).

Gilia spergulifolia Rydb. Outside the canyon between Greenriver and Moab (1971).

Gilia subnuda Torr. Rare in Gray Canyon on the Green River and at the mouth of Dark Canyon (2150).

Hydrophyllaceae

Phacelia corrugata A. Nels. Infrequent at mouth of Dark Canyon (2142A) (2143A).

Boraginaceae

Coldenia hispidissima (Torr.) A. Gray. On the Green River at mouth of Hell Roaring Canyon (2083), and at Bow Knot Bend; in Cataract Canyon at Rapids 13 (2124A), and at mouth of Dark Canyon (2149); common at Lee's Ferry (4341); Vasey's Paradise (2244A); mouth of Havasupai Canyon (2350).

Coldenia plicata (Torr.) Cov. Near Boulder Dock (4183).

Cryptantha barbigera (A. Gray) Greene. Separation Canyon (4234).

Cryptantha crassisepala (Torr. & Gray) Greene. Outside the canyon near Moab (1982); Greenriver (1920) (1951).

Cryptantha Fendleri (A. Gray) Greene. Forbidding Canyon and Rainbow Bridge (4097).

Cryptantha leucopheae (Dougl.) Payson. Outside the canyon five miles north of Moab (1977), and abundant between Montecello and Moab (2003); abundant at Mile 84 on the Green River (2034); in Cataract Canyon frequent at mouth of Dark Canyon (2157).

Cryptantha Wetherillii (Eastw.) Payson. Greenriver (1950A).

Heliotropium curassavicum L. var. *oculatum* (Heller) Johnston. Spencer Canyon (4265).

Verbenaceae

Lippia Wrightii A. Gray. Havasupai Canyon at Navajo (Bridal Veil) Falls (4416).

Verbena bracteata Lag. & Rodr. Greenriver (1934).

Labiatae

Hedeoma nanum (Torr.) Greene. Separation Canyon (4245) (4246).

Solanaceae

Datura meteloides DC. Mouth of Dark Canyon (2171); Glen canyon below the Klondike Bar and nine miles above Lee's Ferry; Lee's Ferry (4336); Vasey's Paradise (2267) and occasional throughout Marble Canyon; mouth of Bright Angel Creek (4105); common in Havasupai Canyon; fairly common on Lake Mead and collected between Spencer Canyon and Emory Falls (4266).

Nicotiana trigonophylla Dunal. Between Navajo Mt. and Rainbow Bridge; in Grand

Canyon along Hermit Creek (2296A), and mouth of Havasupai Canyon (2349); growing abundantly and rankly along the creek in Quartermaster Canyon on Lake Mead (4275).

Physalis crassifolia Benth. Mouth of Bright Angel Creek (4092); common at Separation Rapids (4218) (4220), and fairly common in Spencer Canyon (4252).

Physalis hederaefolia A. Gray. On the Green River at ancient Indian granaries above Hell Roaring Canyon (2090); mouth of Dark Canyon (2151).

Solanum Douglasii Dunal. Havasupai Canyon near creek (4363); Separation Canyon.

Scrophulariaceae

Castilleja linariaefolia Benth. Surprise Valley (4007), Rainbow Bridge (4046), and floor of Forbidding Canyon (4072); North Rim at Port Royal (4308).

Maurandya antirrhiniflora Humb. & Bonpl. Marble Canyon at Mile 16½ (2209A); in Grand Canyon fairly common on sand bars at Conquistadore Aisle (2326), Elves' Chasm (2329), Separation Canyon (4242), one mile up Separation Canyon (4211), and Quartermaster Canyon on Lake Mead (4275A).

Mimulus cardinalis Dougl. Marble Canyon at Vasey's Paradise (2242) (2243); Havasupai Canyon (4425); dense growth at Quartermaster Canyon (4272) (4273 yellow-flowered) and at Emory Falls associated with Aquilegia in Rock crevices in spray of waterfall (4192).

Penstemon ambiguus Torr. Near Rainbow Bridge (4034).

Penstemon barbatus (Cav.) Roth. Mouth of Bright Angel Creek (4106).

Penstemon comarrhenus A. Gray. Outside the canyon south of Moab (1992).

Penstemon Eatonii A. Gray. Mouth of Dark Canyon (2155); Surprise Valley (4022).

Penstemon pachyphyllus A. Gray. Outside the canyon near Montecello (2020).

Penstemon Palmeri A. Gray. South Rim, occasional in first half mile near Kaibab Trail (4116).

Penstemon strictus Benth. Surprise Valley (4019).

Bignoniaceae

Chilopsis linearis (Cav.) Sweet. Marble Canyon at Mile 16½ (2211); Havasupai Canyon (4387); Separation Rapids (4243).

Martyniaceae

Martynia parviflora Woot. Havasupai Canyon (4377).

Plantaginaceae

Plantago fastigiata Morris. Grand Canyon at Tanner Rapids (2288).

Plantago Purshii Roem. & Schult. Outside the canyon south of Moab (1986); Greenriver (1949).

Rubiaceae

Galium stellatum Kellogg var. *eremicum* Hilend & Howell. On the Green River near Yokey's Fat (2081A); in Marble Canyon at Mile 16½ (2202), Mile 26½ (2221) (2226), and President Harding Rapids (2278).

Galium Watsoni (A. Gray) Heller. Elves' Chasm (2331).

Caprifoliaceae

Symphoricarpos sp. South Rim near top of Kaibab Trail (4111), North Rim at Port Royal (4302).

Cucurbitaceae

Cucurbita foetidissima H. B. K. Common near stream in Havasupai Canyon (4373).

Cucurbita palmata S. Wats. Lake Mead two miles above Emory Falls (4196A). Rare in Arizona and apparently new to Mojave Co.

Compositae

Actinea acaulis (Pursh) Spreng. var. *arizonica* (Greene) Blake Outside the canyon between Moab and Montecello (1994).

Actinea Cooperi (A. Gray) Kuntze. First half mile down Kaibab Trail on South Rim (4112).

Aplopappus acradenius (Greene) Blake. Lee's Ferry (2198); Marble Canyon at Mile 26½ (2235); Separation Rapids (4221).

Aplopappus heterophyllus (A. Gray) Blake. Mouth of Diamond Creek (2393); Lee's Ferry (4342).

Aplopappus Nuttallii Torr. & Gray. Outside the canyon five miles north of Moab (1980).

Aplopappus spinulosus (Pursh) DC. var. *turbinellus* (Rydb.) Blake. Two miles above Emory Falls on Lake Mead (4299A).

Artemisia frigida Willd. Common at Port Royal on North Rim (4305A).

Artemisia tridentata Nutt. North Rim at Port Royal (4313).

Aster adscendens Lindl. Surprise Valley (4012).

Aster cichoriaceus (Greene) Blake. Rare at mouth of Dark Canyon (2145); Port Royal on North Rim (4327); fairly common in Havasupai Canyon (4367) (4413).

Aster leiodes Blake? Forbidding Canyon (4074A).

Aster spinosus Benth. Common at Lee's Ferry (2191)? (2192)? (Immature) (4345); in Marble Canyon abundant at Mile 16½ (2207) and Mile 19; Hualapai Canyon; two miles above Emory Falls.

Aster tanacetifolius H. B. K. Frequent on the Green River at Mile 84 (2019A).

Baccharis Emoryi A. Gray. Common near Greenriver (1936); in Gray Canyon above the mouth of Hell Roaring Canyon (2053); Bridge Canyon; in Grand Canyon along Hermit Creek (2294A), and at Deer Creek Falls (2342).

Baccharis glutinosa Pers. Common at Lee's Ferry (2192); in Grand Canyon along Hermit Creek (2293A), 205 Mile Canyon below Spring Canyon (2385A), Separation Canyon, Spencer Canyon, and Quartermaster Canyon.

Baccharis sarothroides A. Gray. Abundant at Lava Falls (2377)?; 205 Mile Canyon below Spring Canyon (2384).

Baccharis sergiloides A. Gray. Two miles above Emory Falls (4293).

Bahia ourolepis Blake. Greenriver (1959) (1950).

Brickellia atractyloides A. Gray. Common above Bass Crossing in Grand Canyon (2311); Separation Canyon (4206A).

Brickellia longifolia S. Wats. Cataract Canyon at Mile Rapids (2135A), and common along the river at mouth of Dark Canyon (2158); in Marble Canyon common at Vasey's Paradise (2265); third half mile near Kaibab Trail on South Rim (4144); common at Conquistadore Aisle in Grand Canyon (2322); two miles above Emory Falls (4299B).

Brickellia oblongifolia Nutt. var. *linifolia* (D. C. Eaton) Robinson. Greenriver (1962).

Brickellia scabra (A. Gray) A. Nels. Greenriver (1945).

Chaenactis Douglasii (Hook.) Hook. & Arn. Outside the canyon between Moab and Greenriver (1971).

Chaenactis stevioides Hook. & Arn. Outside the canyon between Montecello and Moab (2002).

Chrysopsis villosa (Pursh) Nutt. (form). Mouth of Dark Canyon (2174); Surprise Valley (4024), and Forbidding Canyon (4060).

Chrysothamnus nauseosus (Pall.) Britton. On the Green River at Mile 84 (2029) (2036); Cataract Canyon above Rapid 1 (2101), Mile Rapids (2129), and mouth of Dark Canyon (2164); common at Lee's Ferry (2196) (4348); Havasupai Canyon (4378).

Chrysothamnus nauseosus (Pall.) Britton var. *graveolens* (Nutt.) Hall. North Rim at Port Royal (4317).

Chrysothamnus Parryi (A. Gray) Greene var. *nevadensis* (A. Gray) Hall. North Rim at Port Royal (4318).

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *stenophyllus* (A. Gray) Hall. Greenriver 1944; Kaibab Trail, third half mile below South Rim (4140) (4150).

Cirsium canescens Nutt. Infrequent at mouth of Dark Canyon (2176).

Cirsium neomexicanum A. Gray. Surprise Valley (4028).

Cirsium Nidulus (M. E. Jones) Petrak. Outside the canyon between Moab and Montecello (1995); first half mile below the South Rim near Kaibab Trail (4126) (4120A); Port Royal on the North Rim (4321).

Cirsium pulchellum (Greene) Woot. & Standl. (form). Surprise Valley (4015).

Cirsium undulatum (Nutt.) Spreng. Abundant at Lava Falls (2367); two miles above Emory Falls on Lake Mead (4297).

Cirsium sp. (near *C. mojavense* (Greene) Jeps.) Quartermaster Canyon on Lake Mead (4277A).

Dyssodia Thurberi (A. Gray) A. Nels. Abundant at President Harding Rapids (2276); Tanner Rapids (2296).

Encelia farinosa A. Gray. Abundant above Bass Trail (2307); common at Separation Rapids (4233).

Encelia frutescens A. Gray. Cataract Canyon below Mile Rapids (2125A); Havasupai Canyon near Navajo Falls (4417).

Erigeron canadensis L. Rainbow Bridge (4031), and Bridge Canyon (4051); Havasupai Canyon (4390).

Erigeron divergens Torr. & Gray. Bridge Canyon near Rainbow Bridge (4038).

Erigeron lobatus A. Nels. Mouth of Bright Angel Creek (4093); Separation Canyon (4240).

Erigeron utahensis A. Gray. Cataract Canyon below Mile Rapids (2124).

Eupatorium herbaceum (A. Gray) Greene. First half mile below the South Rim near Kaibab Trail (4134).

Franseria acanthocarpa (Hook.) Cov. Greenriver (1961), and at Mile 84 on the Green River (2037); Lee's Ferry (4344); Separation Canyon (4214).

Franseria dumosa A. Gray. Grand Canyon at Mile 193 (2382), and Spencer Canyon (4261); Boulder Dock, infested with *Cuscuta* sp. (4171) (4178).

Gutierrezia divaricata (Nutt.) Torr. & Gray. On the Green River at site of Julian's name (2065).

Gutierrezia lucida Greene. Havasupai Canyon above the village (4404A).

Gutierrezia Sarothrae (Pursh) Britton & Rusby. Mile 26½ in Marble Canyon (2098)?; frequent at Tanner Rapids (2297); North Rim at Port Royal (4329) (4330A); Havasupai Canyon (4374).

Helianthus petiolaris Nutt. (form). Greenriver (1947).

Hofmeisteria pluriseta A. Gray. Separation Rapids (4219).

Hymenopappus lugens Greene. Outside the canyon on roadside east of Greenriver (1966), five miles north of Moab (1979), and abundant between Moab and Montecello (2004).

Iva axillaris Pursh. Greenriver (1927) (1961).

Lactuca scariola L. var. *integrifolia* Bogenhard. Havasupai Canyon (4393).

Laphamia Toumeyi Rob. & Greenm. Kaibab Trail in first half mile below the South Rim (4110).

Malacothrix sonchoides (Nutt.) Torr. & Gray. On the Green River at Mile 84, infrequent (2024).

Melampodium leucanthum Torr. & Gray. Near mouth of Separation Canyon (4244).

Peucephyllum Schottii A. Gray. Between Spencer Canyon and Emory Falls on Lake Mead (4267).

Pluchea sericea (Nutt.) Cov. On the Green River in Gray Canyon (2062), and at mouth of Hell Roaring Canyon (2087); Forbidding Canyon (4074); Lee's Ferry (2187); Tanner Rapids (2287); fourth half mile below the South Rim near Kaibab Trail (4164); mouth of Hermit Creek (2292A); two miles above Emory Falls (4299).

Psilostrophe sparsiflora (A. Gray) A. Nels. South Rim in first half mile near Kaibab Trail (4127).

Senecio stygius Greene. Kaibab Trail in first half mile below the South Rim (4130).

Solidago altissima L. (form). Near Rainbow Bridge (4037).

Solidago petradoria Blake. Mouth of Bright Angel Creek (4108); Port Royal on the North Rim (4320).

Solidago trinervata Greene. Lee's Ferry (4359).

Sonchus oleraceus L. South Rim in first half mile near the Kaibab Trail (4129).

Stephanomeria exigua Nutt. Outside the canyon between Moab and Montecello (2017); on the Green River Mile 84 (2039).

Stephanomeria pauciflora (Torr.) A. Nels. Hell Roaring Canyon (2058); Cataract Canyon below Mile Rapids (2134A), and abundant in Dark Canyon (2169); Havasupai Canyon (4424).

Stephanomeria tenuifolia (Torr.) Hall. North Rim at Port Royal (4324).

Townsendia incana Nutt. Outside the canyon between Montecello and Moab (2007); floor of Forbidding Canyon (4080).

Townsendia strigosa Nutt. Outside the canyon south of Moab (1987).

Trixis californica Kellogg. Common above Bass Trail in Grand Canyon (2310).

Verbesina encelioides (Cav.) Benth. & Hook. var. exauriculata Rob. & Greenn. Havasupai Canyon (4394).

Xanthium pennsylvanicum Wallr. Havasupai Canyon (4389).

Xanthium saccharatum Wallr. Forbidding Canyon (4068); Lee's Ferry (4354).

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Studies in Drepanocladus. II Phytogeography

Frances E. Wynne

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General Distribution of Drepanocladus

World distribution.—*Drepanocladus* has a circumpolar distribution in both hemispheres. In the northern hemisphere it occurs throughout arctic and northern North America, Europe, and Asia. In the southern hemisphere it has been collected in the Andes, southern South America, New Zealand, and Australia. However, *Drepanocladus* is notably lacking in all tropical climates.

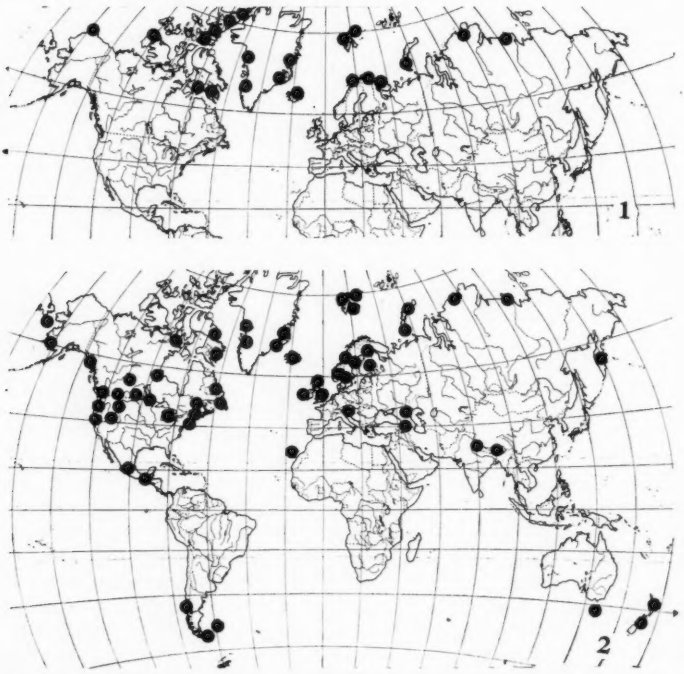
Distribution in the northern hemisphere.—*Drepanocladus* is a characteristic plant of alpine meadows and of arctic and boreal swamps and bogs, and occurs in arctic regions in the Aleutian Islands; Alaska; Ellesmere, Grinnell, Devon, and Baffin Islands of the American Arctic Archipelago; Labrador; Greenland; Iceland; in Europe in Scandinavia, Spitzbergen, Bear Island; in Asia in Franz Joseph Land, Nova Zemblya, the whole Siberian mainland, and Kamchatka. *Drepanocladus* extends southward in North America to California, Nevada, Utah, New Mexico, Mexico, Nebraska, Missouri, Illinois, Indiana, West Virginia, and New Jersey; in Europe the genus extends south in the Pyrenees, the Swiss Alps, the Balkans, and the Caucasus; and in Asia in the Himalayas. As *Drepanocladus* extends farther south it disappears in the lowlands, and occurs only at high altitudes in the mountains.

Flowering plants with similar distribution.—Similar circumpolar distributions occur among the flowering plants, for example: *Deschampsia caespitosa* (L.) Beauv. has been reported from Greenland; arctic and temperate North America, Asia, and Europe; southern South America; Tasmania; and New Zealand; and *Heirochloë alpina* (Schwartz) Roem. & Schult. from North America, the mountains of New England; eastern Asia, the mountains of central Asia; Australia; and New Zealand.

Classification of Species of Drepanocladus

Geographical.—The species of *Drepanocladus* may be classified geographically into two groups—arctic-alpine and boreal-montane. The arctic-alpine species are *D. badius, D. brevifolius, D. fluitans* var. *Berggreni,* and *D. lycopodioides;* the boreal-montane species are *D. aduncus, D. fluitans, D. exannulatus, D. revolvens, D. vernicosus,* and *D. uncinatus.*

The arctic-alpine species (map 1) are more restricted in their range than the boreal-montane species, which may be due as much to imperfect knowledge as to the actual distribution of the plants. The boreal regions have been relatively more thoroughly explored for plants than the arctic regions. This accounts for the small number of collections of the arctic-alpine species. However, the fact that the arctic-alpine species have never been collected in the well explored boreal regions indicates that their range is actually restricted to the extreme north where they undoubtedly occure more frequently than they have been collected.*Drepanocladus fluitans* var. *Berggreni* is known from



Map 1. World distribution of the arctic-alpine species of *Drepanocladus.* Map 2. World distribution of the boreal-montane species of *Drepanocladus.* Reprinted by permission from "Outline Maps and Graphs" by R. B. Hall, published by John Wiley & Sons, Inc.

arctic Norway, Sweden, Greenland, and Ellesmere Island. *Drepanocladus brevifolius* and *D. badius* have been collected most often of the arctic-alpine species; they have been found in Siberia, Spitzbergen, Bear Island, Greenland, and arctic America. *Drepanocladus badius* occurs also in northern Scandinavia and Labrador and in the islands northward.

The boreal-montane species (map 2), *D. aduncus, D. fluitans, D. exannulatus, D. vernicosus, D. revolvens,* and *D. uncinatus,* are widespread in the arctic regions; nevertheless, they are most abundant in more temperate climates where they occur in boreal bogs and swamps and along the mountain ranges. These six species are found in arctic Europe and Asia and occur as far south as the alps in Europe. In addition, *D. exannulatus* is found in the Caucasus and the Himalayas; *D. fluitans* occurs in the Pyrenees and the higher mountains of the Canary Islands; and *D. aduncus* has been reported from the Caucasus.

In eastern North America the boreal-montane species of *Drepanocladus* occur from the arctic southward to New Jersey, West Virginia, Ohio, Illinois, and Missouri. In western North America the southern limits of the boreal-montane species of *Drepanocladus* are in the mountains of Nebraska, New Mexico, Utah, Nevada, California, and Mexico.

Genetical.—The species of *Drepanocladus* are rather sharply divided into two categories on the basis of fundamental variability. Some species are extremely adaptable and respond to the slightest change in environmental conditions. So great is the adaptability that on one plant, leaves produced at different times under different conditions vary so greatly that they could be placed in separate varieties if it were not known that they came from the same stem. In contrast to the variable species, the stable species of *Drepanocladus* are clear-cut and well-defined.

The correlation between the stable and the arctic-alpine species *(D. badius, D. brevifolius, D. lycopodioides,* and *D. fluitans* var. *Berggreni)* and the variable and the boreal-montane species *(D. aduncus, D. fluitans, D. exannulatus, D. revolvens, D. vernicosus,* and *D. uncinatus)* is striking. This division is exactly what one would expect from a consideration of the ranges of the species of *Drepanocladus.* The stable arctic-alpine species are limited to one region and to one type of habitat. The variable boreal-montane species, however, tolerate a wide variety of habitats and consequently have spread over a wider range.

Even within the boreal-montane group, the variability of each species correlates with its distribution. *D. fluitans, D. exannulatus* and *D. aduncus* are extraordinarily variable and respond to every change in the environment. Of these, *D. aduncus* is the most variable and adaptable, and therefore is the most widespread geographically. It has a continuous distribution in North America, extends across the entire northern part of the continent, and ranges farther south than any other species of *Drepanocladus* to New Mexico, North and South Dakota, Nebraska, and Missouri. *D. fluitans* is most common in eastern North America where the very wet habitats it requires are most abundant. *D. exannulatus* is frequent in eastern North America and in the western mountains. Both *D. fluitans* and *D. exannulatus* are completely lacking in the

plains of the central part of the continent. Apparently they are unable to resist periods of dryness and cannot live, with *D. aduncus,* in the intermittent streams and ponds of central North America.

Of the boreal-montane group, *D. revolvens, D. vernicosus,* and *D. uncinatus* are the most clear-cut species. Of these three, *D. vernicosus* has been collected least frequently. Like *D. exannulatus* and *D. fluitans,* it does not occur in the central part of North America. *D. revolvens,* of the boreal-montane species, is the most restricted in range and variability. Although it seems a well-defined and natural species to me, many bryologists have recognized a variety, and even another species, *intermedius.* It is definitely restricted in its habitat to boreal bogs and swamps and arctic meadows, and therefore has a more northern distribution than any other boreal-montane species.

Because *D. uncinatus* grows in xerophytic or mesophytic instead of hydrophytic habitats, conditions governing its distribution and variability are different from those affecting other species of *Drepanocladus.* Like *D. revolvens,* it is a well-defined, natural species. In fact, it is so distinctive in its habitat and diagnostic features that Loeske (1907) created the genus *Sanionia* for *D. uncinatus* and its varieties. Nevertheless, it is much more variable and adaptable than any of the arctic-alpine species and it has the distribution characteristic of the boreal-montane species of *Drepanocladus.*

Vascular plants with similar distribution.—It is interesting to compare the ranges of bryophytes with those of vascular plants. The following lists, which include only a few of the possible examples, were compiled from Hultén (1937) and Polunin (1940); the nomenclature follows Polunin.

Although the range of any single species cited here may be discontinuous, together they show a distribution similar to that of the arctic-alpine species of *Drepanocladus.*

Antennaria angustata Greene
Arctagrostis latifolia (R. Br.) Griseb.
Carex rariflora (Wahlenb.) Sm.
Cochlearia officinalis L.
Colpodium fulvum (Trin.) Griseb.
Draba alpina L.
Draba cinerea Adams
Draba nivalis Liljebl.
Dryopteris fragrans (L.) Schott.
Elymus arenarius L.
Luzula nivalis (Laest.) Buerl.
Lychnis furcata (Raf.) Fernald
Pedicularis labradorica Wirsing
Pedicularis lapponica L.
Pedicularis sudetica Willd.
Poa glauca M. Vahl
Primula egaliksensis Wormskj.
Puccinellia phryganodes (Trin.) Scribn.
Ranunculus nivalis L.
Salix arctica Pall.
Stellaria humifusa Rottb.

The following plants have ranges similar to the boreal-montane species of *Drepanocladus.*

Alopecurus alpinus Sm.
Andromeda Polifolia L.
Artemisia borealis Pall.
Astragalus eucosmus Robinson
Callitriche verna L.
Carex Bigelowii Torrey & Schwein.
Carex bipartita All.
Carex capillaris L.
Carex misandra R. Br.
Carex rupestris All.
Lychnis apetala L.
Oxyria digyna (L.) Hill
Oxytropis foliolosa Hook.
Pedicularis capitata Adams
Pedicularis lanata Cham. & Schl.
Poa alpina L.
Poa arctica R. Br.
Polygonum viviparum L.
Potentilla nivea L.
Potentilla palustris (L.) Scop.

Cassiope tetragona (L.) D. Don.
Draba fladnizensis Wulfen
Dryas octopetala L.
Empetrum nigrum L.
Epilobium angustifolium L.
Eriophorum Scheuchzeri Hoppe
Festuca brachyphylla Schultes
Hippuris vulgaris L.
Juncus albescens (Lange) Fernald
Juncus biglumis L.
Juncus castaneus Smith
Kobresia simpliciuscula (Wahlenb.) Mack.
Koenigia islandica L.
Ledum palustre L.
Luzula spicata (L.) DC.
Primula stricta Hornem.
Pyrola secunda L.
Ranunculus pedatifidus J. E. Smith
Ranunculus pygmaeus Wahlenb.
Ranunculus sulphureus Solander
Saxifraga caespitosa L.
Saxifraga cernua L.
Saxifraga flagellaris Willd.
Saxifraga hieracifolia Waldst. & Kit.
Saxifraga oppositifolia L.
Silene acaulis L.
Thalictrum alpinum L.
Tofieldia palustris Wahlenb.
Vaccinium Vitis-Idaea L.
Veronica alpina L.
Woodsia ilvensis (L.) R. Br.

Drepanocladus and Pleistocene Glaciation

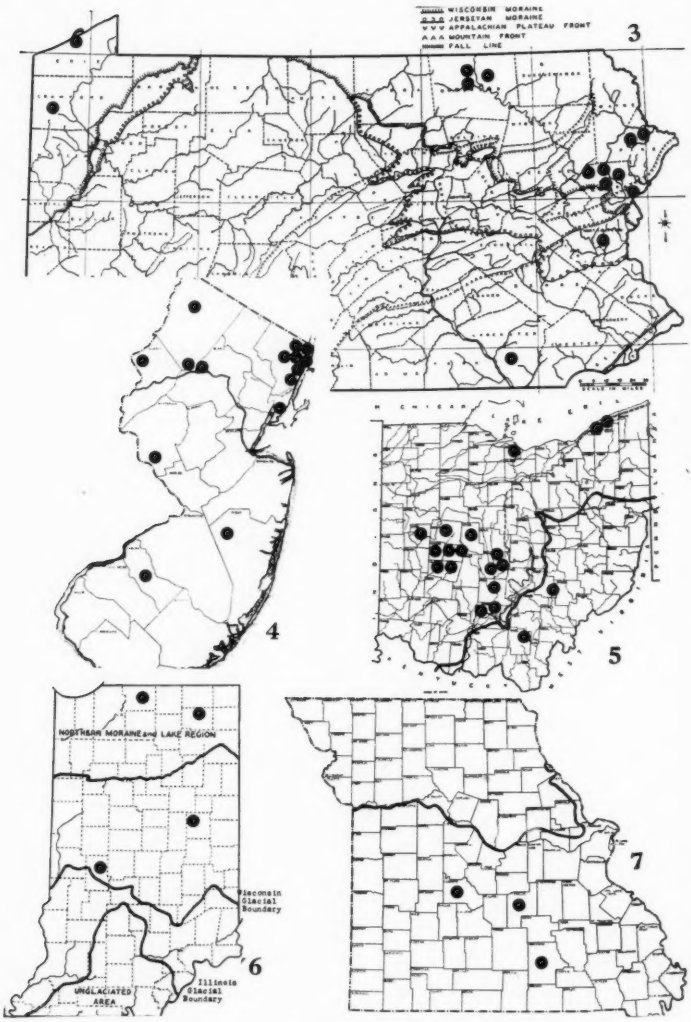
Correlation of present distribution of Drepanocladus with the Pleistocene glaciation.—The present range of *Drepanocladus* coincides rather well with the maximum extent of continental glaciation during the Pleistocene epoch. This is especially well shown by the correlation of the southernmost boundary of the distribution of the genus and the boundaries of the various Pleistocene till sheets. Since I have considered only American species, I shall confine specific examples of distribution to North America.

Eastern North America.—In the eastern part of North America, the genus is not found in states (with the exception of West Virginia) that lie entirely south of the maximum extent of the Pleistocene glaciation. For instance, there are no records of *Drepanocladus* in Virginia, Kentucky, or Arkansas or in the states southward. However, *Drepanocladus* shows a significant distribution in the states which were partially glaciated. In Pennsylvania, Indiana, Ohio, and New Jersey, the genus occurs commonly only in the glaciated area of the state, although there are isolated stations south of the maximum extent of the glaciation as it is recognized today (see maps 3 to 6).

The only plants of *Drepanocladus* I have seen from regions south of the Wisconsin and Jerseyan moraines in Pennsylvania are J. K. Small's collections of *D. fluitans* from Smithville Swamp, Lancaster County (map 3). Dr. John M. Fogg of the University of Pennsylvania says *(in litt.)*:

> Smithville . . . has long been recognized as one of the most peculiar spots in the south-eastern corner of the state. It is, or was, at one time, a large bog, or rather a series of bogs, in which occurred a remarkable assemblage of coastal plain species, among which were intermixed a few plants of distinctly boreal range. Among the latter the most spectacular was *Juncus balticus* var. *littoralis*, here known at its only station, I believe, south of the Wisconsin moraine. Unfortunately, the Smithville area has been almost entirely destroyed by subsequent draining and filling, so that there is little, if anything, of real botanical interest there today.

In New Jersey, *Drepanocladus* is abundant in the glaciated parts of the state; I have seen numerous collections from the heavily glaciated Sussex, Morris, Warren, Bergen, and Hudson Counties. The genus also occurs in



The distribution of *Drepanocladus* in relation to the glacial border. Map 4. In Pennsylvania. Map 4. In New Jersey. Copyright, American Map Co., Inc., New York, No. 10589. Map 5. In Ohio. Reproduced through courtesy of C. H. Jones. Map 6. In Indiana. Reproduced through courtesy of Charles C. Deam. Map 7. In Missouri. Copyright, American Map Co., Inc. New York, No. 10589.

New Jersey in the pine barrens of Ocean and Burlington Counties, a region where numerous swales, sloughs, and intermittent streams provide suitable habitats (map 4).

Ohio has long been noted for the diverse geographic affinities of its flora because of its numerous disjunct species characteristic of prairie, plains, hemlock-hardwood, and boreal plant formations. The persistence of boreal relic species in bogs, coves, on cliff tops, and sand dunes is a conspicuous feature of the glaciated area of the state. A few of these boreal relics are found in the unglaciated area of Ohio. According to Braun (1928), groves of *Thuja occidentalis* L. occur along the borders of the Illinoian drift at the edge of the "hill country" where the varied topography favors the persistence of diverse plant communities. Associated with arbor vitae are *Carex eburnea* Boott. and *Viola arenaria* DC.

Other northern plants which occur in the glaciated area of Ohio or along the borders of the Illinoian drift are (Thompson 1939): *Alnus americana* L., *Betula pumila* L., *Epipactis tesselata* (Lodd.) A. A. Eaton, *Hypericum majus* (Gray) Britton, *Larix laricina* (DuRoi) Koch., *Lathyrus palustris* L., *Ledum groenlandicum* Oeder., *Linnaea americana* L., *Menyanthes trifoliata* L., *Potentilla palustris* (L.) Scop., *Pyrola secunda* L., *Salix candida* Flugge, *Salix pedicellaris* Pursh., *Shepherdia canadensis* (L.) Nutt.

Two relic localities for *Drepanocladus* are known in Jackson and Perry Counties (map 5). Of these areas Dr. R. T. Wareham of Ohio State University says *(in litt.)*:

> Liberty Township, Jackson County is perhaps the richest area floristically of any in Ohio. There are high cliffs, deep gorges, and many springs. Proglacial Lake Tight (Wolfe 1942) covered a large portion of the county but perhaps only half of Liberty Township. Perry County has had much the same history but the cap rock is somewhat different and therefore the topography is different.

Braun (1928) believes that the boreal colonies of the unglaciated area of Ohio are probably relics of the coniferous belt established during the Illinoian glaciation and persist today for the most part in areas not especially favorable to the deciduous forest. Since they occur on areas which, to our knowledge, have never been glaciated, they probably existed in their present localities during most of the Pleistocene or at least since the Illinoian.

Drepanocladus has never been collected on the unglaciated portion of Indiana nor on the Illinoian till sheet in that state (map 6). Flowering plants that show a similar distribution in Indiana (Welch 1936) are: *Carex projecta* Mack., *Circaea alpina* L., *Cornus rugosa* Lam., *Cypripedium reginae* Ait., *Diervilla Lonicera* Mill., *Gentiana procera* Holm., *Habenaria orbiculata* (Pursh) Torr., *Hydrocotyle americana* L., *Maianthemum canadense* Desf., *Pinus Strobus* L., *Potentilla fruticosa* L., *Prunus nigra* Ait., *Schizachne purpurascens* (Torr.) Swallen, *Taxus canadensis* Marsh, *Vaccinium canadense* Kalm.

Drepanocladus occurs in Missouri in the Ozarks south of the Kansan and Iowan till sheets (map 7). *D. aduncus* has been collected in Ellis Spring, Camden County and in springs near Round Spring State Park, Shannon

County. Since the genus apparently occurs only in the springs in Missouri, Steyermark's study of the phanerogamic flora of the fresh-water springs in the Ozarks (1941) is pertinent. He has reported that several phanerogams which are otherwise restricted to glaciated areas in North America occur in the springs in the Ozarks, namely: *Anacharis occidentalis* (Pursh) Victorin, *Eleocharis acicularis* (L.) R. & S., *Lemna trisulca* L., and *Veronica connata* Raf. These plants, which also occur in Iowa, Minnesota, Wisconsin, Indiana, and states northward, do not occur in northern Missouri but are restricted to the Ozarks. Steyermark believes that the limiting factor is the

> suitable habitat of cooler waters found in the Ozark springs as compared to the temperature found in rivers, lakes, sloughs, and other types of aquatic environment in other parts of the state. . . . The only property possessed by Ozark Springs which is not duplicated in streams, lakes, sloughs, and other bodies of water in Missouri, is cold water . . . species may be found abundantly in spring water, but are totally lacking in the slightly warmer but otherwise similar waters of the Ozark streams into which the spring water empties. . . . Sometimes the cooler spring water persists for a few hundred feet down the main stream into which it empties, and as long as the influence of the cooler temperature of its water persists, so does the vegetation characteristic of the spring water (p. 530).

Steyermark believes that these plants characteristic of springs in the Ozarks do not occur in the northern glaciated area of Missouri because there are no suitable habitats on the Kansan and Iowan till sheets of that region. Missouri was not covered by the more recent Illinoian and Wisconsin ice sheets; therefore the morainal topography of northern Missouri is old and is not characteristic of areas which have been glaciated. Consequently, no habitats suitable for *Drepanocladus* exist in that region.

West Virginia is the only state entirely unglaciated during the Pleistocene from which I have seen specimens of *Drepanocladus*. The occurrence of the genus in West Virginia is apparently due to drainage and soil factors combined with a relic Pleistocene distribution. Core (1932) discusses the effect of the Pleistocene glaciation upon the flora of West Virginia as follows:

> The Pleistocene glaciation did not reach West Virginia, the terminal moraine being 25 miles or more from the northern boundaries, yet it is probable that at that time at least the northern part of the state must have presented the aspect of an Arctic tundra, while many Canadian species were forced hundreds of miles farther south. Upon the retreat of the ice sheet and the consequent northward migration of biota, some of these species were left behind on the cold mountain tops throughout the Appalachians. Relic colonies of tundra, persisting in mountain glades, were surrounded by the migrating forests and are still in process of being replaced by succession (p. 70).

A combination of factors has enabled these northern habitats to persist in the mountains of West Virginia today. Core states:

> Here and there throughout the higher mountains, where the drainage is impeded due to resistant masses of conglomerate or other sandstone, are formed topographic features known locally as "glades," which resemble in a striking manner the bogs of farther north. In these glades may be found species of *Sphagnum, Cladonia,* etc., as well as such vascular plants as *Aspidium simulatum, Larix laricina, Carex trisperma, Pogonia ophioglossoides, Calopogon pulchellum, Alnus incana, Coptis trifolia, Drosera rotundifolia, Geum rivale, Vaccinium oxycoccos* . . . (p. 68).

I have seen two specimens of *D. fluitans* and one of *D. exannulatus* var. *Rotae* from Pocahontas County. Dr. Core says of this area *(in litt.)*:

> There are, indeed, many plants of unequal distribution in the Pocahontas County area. . . . Northern species of vascular plants ranging southwards along the high Alleghenies of Pocahontas and (or) adjacent counties include *Picea rubra*, *Betula lutea*, *Sorbus americana*, *Acer spicatum*, *Clintonia borealis*, *Streptopus roseus*, *Cornus canadensis*, *Chiogenes hispidula*, *Potentilla tridentata*, *Pogonia ophioglossiodes*, *Coptis trifolia*, *Andromeda glaucophylla*, *Geum rivale*, *Vaccinium macrocarpon*, and *Menyanthes trifoliata*.

The only other locality in West Virginia from which I have seen plants of *Drepanocladus (D. fluitans)* is the Cranesville Swamp in Preston County. Dr. Core says of this area *(in litt.)*:

> Cranesville Glade is a local name for a large swamp 12 miles north of Terra Alta, in Preston County. The area, covering several hundred acres, lies at an elevation of approximately 2600 feet and is surrounded by low mountain ranges that rise gradually to over 3000 feet. The swamp was originally heavily wooded with tamarack (southernmost station), red pine (until recently southernmost known station), black ash, spruce, etc., with open places where grow *Sphagnum*, cranberry, thread-of-gold, *Dalibarda*, etc. It is, thus, distinctly a northern habitat.

Western North America.—Extensive mountain glaciation in western North America was concomitant with the continental glaciation of the eastern part of the continent. In both regions apparently several glacial stages were separated by interglacial stages of various lengths. Times when many of the deep canyons were occupied by long tongues of ice alternated with interglacial periods when such glaciers shrank to mere vestiges or entirely disappeared. Blackwelder (1931) has proposed a tentative correlation of glacial stages in western United States (as known in Montana, Wyoming, Colorado, Utah, Nevada, and California) with the well known Wisconsin, Iowan, Illinoian, Kansan, and Nebraskan stages in eastern United States. He believes that the best evidence for this general correlation is the "climatic pulsations for which the Pleistocene period is noted. Such climatic variations, if due to general atmospheric or perhaps astronomic causes must have affected all parts of the region." Ray (1940) has shown further that the five sub-stages of the Wisconsin glaciation are the same in the Cache la Poudre Valley in the Colorado Front Range as in the Southern Rocky Mountains from southern Wyoming to Santa Fe, New Mexico. Furthermore, Bryan (1941) has correlated stages in the southern Rockies with the continental glaciation of North America and Europe.

It seems logical that, since the glacial history in eastern and western North America was similar, it should have produced similar effects on vegetation. The cordilleran glaciation, as well as the continental glaciation, formed many bogs and swamps which now provide suitable habitats for *Drepanocladus*. Consequently, the distribution of the genus today parallels the maximum extent of cordilleran, as well as continental, glaciation during the Pleistocene; a map showing the extent of glaciation in western North America very much resembles a distribution map of *Drepanocladus* in that region.

A detailed study of the distribution of *Drepanocladus* in the western United States shows that the southern limits of the genus are always in the

mountains. *D. aduncus* is found in Nebraska in the Pine Ridge; in New Mexico in the Gallina Mountains and in the Sangré de Cristo Range; in Utah in the mountains north of Great Salt Lake and the Uinta Mountains; and in California in the San Bernardino Mountains. The southern limits of *D. exannulatus* are in the Tetons of Wyoming; the Rocky Mountains of Colorado; the canyons of Tavaputs Plateau in Utah; the Sierras of California. *D. fluitans* occurs as far south as the Absaroka range in Wyoming and the Rockies in Colorado.

The same factors that limit *Drepanocladus* to the mountains in the western United States account for its occurrence in the mountains of Mexico, Guatemala *(D. exannulatus* and *D. aduncus)* and in the Chilean Andes *(D. uncinatus)*. It is apparently less common in the southern cordilleran ranges than in the northern mountains.

The ability of Drepanocladus to pioneer on glaciated areas.—The wide distribution of *Drepanocladus* over the glaciated areas of the world is directly related to its remarkable ability to pioneer on new lands. The several retrogressions of the ice front during the Pleistocene with each resulting interglacial period opened vast areas for plant colonization. That the species of *Drepanocladus* established themselves during the interglacial periods in areas previously covered by ice is proven by the numerous fossil mosses found in interglacial deposits.

A large number of fossil *Drepanocladi* have been found in Iowa. I have seen the following collections: *D. exannulatus,* 15 feet below the surface near Mud Lake, Emmett County, B. O. Wolden (NY, DUKE) (Grout, 1930, as *D. fluitans* var. *Jeanbernati*); *D. revolvens* and *D. fluitans,* 32 feet below the surface, Oelwein, Fayette County, T. H. Macbride (NY) (Holzinger, 1903; Savage, 1905; Macbride, 1897).

Steere (1942) has studied some fossil material from Afton, Union County, Iowa. Included among other Bryophyta were several species of *Drepanocladus: D. aduncus, D. fluitans. D. exannulatus, D. revolvens,* and *D. apiculatus,* a fossil species closely related to *D. revolvens.* These mosses were deposited during the first interglacial period, the Aftonian, between the Nebraskan and Kansan invasions.

There are numerous other references in the literature to species of *Drepanocladus* found in Aftonian deposits in Iowa: *D. fluitans* from Dodge Township, Union County (Savage, 1904); *D. fluitans* var. *glaciale* from Iowa City, Johnson County (Holzinger, 1903); *D. aduncus* from Davenport, Scott County (Pratt, 1876).

Records of fossil *Drepanocladi* are not confined to Iowa, however. I have seen peat from Madoc County, California, composed entirely of *D. aduncus* var. *typicus* (aquatic phase) which must occur in large quantity, as it is a commercial product. R. S. Williams (1930) has reported three fossil mosses from Minneapolis, Minnesota, including the new fossil species, *D. minnesotensis* which is closely related to, if not identical with, *D. aduncus.* Cooper and Foot (1932) in discussing the same deposit, mention also "*D. fluitans submersus.*"

The most striking feature about these interglacial fossils is that all the species represented are boreal-montane species. This fact leads one to conclude that the boreal-montane species of *Drepanocladus* were colonizing on the Kansan till sheet during the Aftonian interglacial period just as they are colonizing on the Wisconsin till sheet today. The fact that none of the arctic-alpine species are found south of the arctic, either as living or fossil plants, points to the conclusion that they have always been confined to the extreme north.

Survival of Drepanocladus during the Pleistocene.—Since the species of *Drepanocladus* are now confined to the part of the world glaciated during the Pleistocene, it is obvious that glaciation is an important limiting factor in distribution. Because *Drepanocladus* grows only in the bogs and swamps that are the result of glaciation, the thought that its present distribution is merely the result of a habitat preference immediately arises. However, several facts indicate that the situation is more complex. One species, *D. uncinatus,* is almost xerophytic, growing over logs, banks, and the bases of trees. These habitats are not confined to areas which have been glaciated, yet *D. uncinatus* is. Furthermore, certain species of *Leptodictyum, Hygroamblystegium,* and *Cratoneuron* are frequently found growing with *Drepanocladus.* These species also occur in the swamps of Florida and other semi-tropical regions where *Drepanocladus* has never been found. The difference, then, is one of plants and not of habitats.

Before considering the mechanism whereby the Pleistocene glaciation might have affected the genus, it is important to consider the survival of *Drepanocladus* during the time when much of its present area was ice covered.

There are four types of places in which *Drepanocladus* might have found refuge during the Pleistocene: areas outside the maximum boundaries of the ice sheets, such as (a) south of the Pleistocene ice (b) north of the ice sheets (c) on unglaciated lowlands, and areas within the generally glaciated territory, such as nunataks.

Survival outside the maximum boundaries of the ice sheets.—a. South of glaciation. We have no reasons, from either fossil or modern evidence, to believe that plants were absent close to the edge of the ice. Studies of modern glaciers and Pleistocene fossil deposits indicate the conditions at the edge of the continental glaciers.

Greenland, which, except for a narrow coastal margin and the northern regions, is today entirely covered with an ice cap, affords the best example of the continental Pleistocene glaciers. Greenland has been rather well explored and the vegetation at the ice front is well known. Koch (1928) describes one of the smaller ice sheets as follows:

> The ice front . . . consists of a series of snow-drifts whose length varies from 50-800 meters. . . . After crossing the snow-drifts we encountered a morainic landscape. . . . Hills, 5-10 meters high alternated with sandy plains and depressions filled with clay and occasional small lakes and snow-drifts occurred. Patches with vegetation also occurred, for instance, Papavers, Cerastium, Koenigia, Saxifraga, Luzula, Carex, as also moss and lichens . . . (p. 226).

Swamps result from the melting of the ice. Seidenfaden (1931) states:

> In places where the water has no outlet, thus in all depressions in the ground, there will be a surplus of water as soon as the melting of the snow has set in. . . . In such places there will, according to circumstances, be formed a swamp or a lake with its own more or less varying types of vegetation. . . . These swamps, the only formation in which mosses play an essential part, occur everywhere where there is the slightest depression in the ground; it must be remembered that the solid substratum (ice) lies immediately below the surface of the land and at a nearly constant distance from it; thus the presence of a ridge only about 80 cm. high will give rise to the formation of a swamp behind it (p. 7).

According to Koch (1928) the vegetation on the north coast of Greenland is restricted to such "places where water has gathered owing to the form of the ground. This is particularly below the edges of glaciers and of large snow drifts, from which water trickles and round the shores of small lakes" (p. 366). Thus it is obvious that not only are there suitable habitats for such bog and swamp plants as *Drepanocladus* near glaciers, but also that those plants are actually living in such habitats today.

Wilson (1932) in his study of the fossil remains in the Two Creeks Forest Bed, has been able to reconstruct conditions as they probably existed at the edge of the Pleistocene ice. The Two Creeks forest in Manitowac County, Wisconsin, existed during the interglacial interval between the late and middle substages of the Wisconsin glaciation. Fossil logs show that the interglacial interval must have been long enough to allow the growth of an 82 year old forest. From the condition of the stumps, Wilson concluded that the trees were living when the glacier buried them.

> All the logs . . . show ragged splintering ends in consequence of glacial action upon the trees. This condition indicates a violent twisting and bending of live trees before they were felled (p. 37).

Some of the leaves of the fossilized mosses contained remnants of chloroplasts which Wilson interprets as "strong evidence that the mosses were living at the time of burial."

That plants were living when the ice readvanced indicates that there was not a large barren area immediately before the ice, and that plants could remain alive at the ice front. Study of the Two Creeks Forest Bed also proves that bogs appeared south of the advancing ice supplanting the mesophytic conditions which previously existed. The land snails, the mosses (e.g. *Bryum cyclophyllum* (Schw.) B. & S.), and the grasses characteristic of a forest floor vegetation, as well as the poorly developed (sometimes wanting) peat indicated to Wilson that the Two Creeks Forest Bed was, at one stage of its existence, a mesophytic forest. From the remains of this forest there is a gradual transition to entirely aquatic species of plants and animals. Wilson states (p. 41) that apparently the only plants that were able to thrive during the last years of this interval were aquatic and subaquatic mosses including *Byrum bimum* Schreb., *Calliergon cordifolium* Kindb., *C. turgescens* (Jens.) Kindb., *Camptothecium nitens* Schlp., *Campylium stellatum* (Schreb.) Bryhn, *Drepanocladus aduncus* Mönkem. var. *pseudofluitans* Sanio, *D. revolvens* (Sw.) Warnst., *D. Sendtneri* (Schp.) Warnst., *D. vernicosus* (Limpr.) Warnst.,

D. Wilsoni (Schp.) Roth, *Scorpidium scorpioides* (L.) Limpr. Mollusks found at the same level as the above named mosses were the following aquatic species: *Gyraulus circumstriatus* (Tryon), *Fossaria parva* (Lea.), *Pisidium* sp.

That the character of the forest changed several times during its history is shown by the three distinct periods apparent in the fossil remains: (1) aquatic and semi-aquatic mollusks on top of the varved clay of early Lake Chicago; (2) moist- to dry-woodland mosses, mollusks, mites, fungi, and trees marking an interval of dry land; (3) water mosses, water mollusks, and sediment caused by the re-advance of the ice blocking the drainage.

Cooper and Foot (1932), by comparing the fossil record of a late-Pleistocene community in Minneapolis, Minnesota, with bogs existing today in Alaska, have been able to add to our knowledge of conditions at the edge of the Pleistocene ice sheets. Of the fossil bed in Minneapolis they say:

> The history recorded in this bed is as follows. Sedimentation, which had been heavy for a time, gradually slackened and aquatic mosses began to grow, *Drepanocladus*, having a hard time of it at first, finally attaining dominance. Control passed from one to another of the mosses [*Neocalliergon integrifolium* Williams and *Calliergon giganteum* (Schp.) Kindb.], until the renewal of active sedimentation put an end to their growth. The natural supposition would be that the mosses floated just below the surface of the pond . . . (p. 67).

The mollusca, pollen, cones, and fruits enable the authors to reconstruct the vegetation of the time as follows:

> A morainic or outwash pond, sometimes flooded by silt-laden water, supported an intermittent vegetation of mosses, *Chara* and pondweeds, to which, if it were worth while, we might add an extensive group of probable companion species. . . . Nearby, in depressions of less depth, or possibly in sheltered re-entrants of this low area, grew communities of bog trees with their characteristic accompanying species. Upon the uplands . . . stood the climax forest of white spruce, balsam fir, white pine and birch, just as we find it today in northernmost Minnesota and upon Isle Royale. Branches, twigs, cones, and seed may have fallen from these trees directly into the water, and quantities of their pollen would inevitably reach the same destination.

During an expedition to southeastern Alaska in the summer of 1929 Cooper studied a locality that is remarkably parallel to the one in Minneapolis —a morainic pond in front of the Davidson Glacier.

> The pond in question lies near the outer margin of the morainic belt, and is surrounded by a dense forest of youthful Sitka spruce (*Picea sitchensis* Carr), in height seventy or eighty feet, with a maximum diameter of two feet. A few cottonwoods (*Populus trichocarpa* Hook.) are interspersed.

By studying the ages of the trees (60-76 years), and with knowledge of similar localities in southeastern Alaska, Cooper concluded that "the spot was uncovered by the melting of the ice one hundred to one hundred and fifty years ago." He continues:

> The open water of the pond contained quantities of one of the same mosses found in the Minneapolis locality—*Calliergon giganteum*—also enormous amounts of *Chara* and two species of *Potamogeton*. In addition, another aquatic moss was present—*Fontinalis antipyretica gigantea* Sull. Emergent aquatics filled the shallower portions, *Equisetum fluviatile* L. being most important.

Therefore, from the fossil and living evidence, it is obvious that plants (including *Drepanocladus*) lived in favorable habitats at the edge of the

Pleistocene ice sheets. That habitats favorable for *Drepanocladus* commonly existed at the edge of the ice is proven by the swamps and lakes formed at the edge of the modern glaciers in Greenland and Alaska and by the fossil interglacial bogs. Moreover, if ice-buried Greenland can support along its narrow rim today over four hundred species of vascular plants and numerous cryptogams, certainly plants could have existed along the edge of the Wisconsin ice. It is equally obvious that the plants living at the edge of the ice could invade territory immediately after the melting of the ice sheets. If it took less than 150 years for bryophytes to come into the morainic ponds at the Davidson Glacier in Alaska, it should have taken no longer in the Pleistocene. Moreover, the fossils prove conclusively that the glaciated area was reinhabited with plants during each interglacial period.

In studying present ranges of the species of *Drepanocladus*, it is obvious that only the boreal-montane species, and not the arctic-alpine species, could and did exist south of the Pleistocene ice. All the boreal-montane species (except *D. vernicosus* and *D. uncinatus*) have been found in inter-glacial deposits; the two fossil species (*D. minnesotensis* and *D. apiculatus*) are closely related to the living boreal-montane species *D. aduncus* and *D. revolvens*. The presence of the boreal-montane species in the fossil beds of Iowa near the southern limit of their range proves that those species existed there during interglacial times and indicates that when Iowa was ice-covered, *Drepanocladus* probably lived in the ponds and lakes at the ice-front. All the locations that are today south of the maximum extent of Pleistocene glaciation, such as: the pine barrens of New Jersey; Lancaster County, Pennsylvania; Jackson and Perry Counties, Ohio; the Ozarks of Missouri; and Preston and Pocahontas Counties of West Virginia may be relics of this Pleistocene distribution. The fact that the boreal-montane species today extend to and slightly beyond the southern boundary of the continental glaciation is an indication that they lived there during the Pleistocene epoch.

The retreat of the ice front opened many avenues for the northward migration of plants and recolonization took place along the coastal plain as well as in the interior of the continent. During the maximum development of the last ice advance (and probably during the entire Pelistocene), a very large portion of the now submerged coastal bench was above the sea level, opening a route to the north. There are many flowering plants whose present distribution can best be explained by the presence of a coastal plain along which migration could take place.

Fernald (1911) explained the occurrence of a large percentage of coastal plain species in Newfoundland by means of the same coastal plain along which plants could have migrated:

> Here, then, would be a strip of sands and similar soils stretching with only slight interruptions from our South Atlantic coast to Newfoundland, and it is probable that not far in the wake of the receding ice and the more boreal plants and animals the Coastal Plain plants with the Newfoundland vole and the muskrat crossed on this sandy bridge to Newfoundand. . . .

Potter (1932) was interested in such plants as *Zannichellia palustris* L. var. *major* (Boenn.) Koch., *Glaux maritima* L. var. *obtusifolia* Fernald, *Caex mari-*

tima O. F. Mueller, *Juncus Gerardi* Loisel., *Plantago juncoides* Lam. var. *decipiens* (Barneoud) Fernald, and *Zosteria marina* L., which are distributed along the Atlantic coast from New Jersey to the Gulf of St. Lawrence and also occur in the Hudson Bay region. Potter explains the distribution of these plants by postulating migration northward along the Atlantic coastal plain and then to the Hudson Bay along the shores of inland post-Pleistocene seas.

The central part of the continent could have been reached, as Gleason (1922) has shown, not only by migration directly northward, but also by migration along the shores of the Champlain Sea. During the Algonquin and Nipissing stages of the Great Lakes entrance to the lake region was gained along the Kirkfield and North Bay outlets. The occurrence in the Great Lakes region of such coastal plain species as *Ammophila arenaria* (L.) Link., *Elymus arenarius* L., *Juncus balticus* Willd., *Cakile edentula* (Bigel.) Hook., *Prunus pumila* L., *Lathyrus maritimus* (L.) Bigel., *Hudsonia tomentosa* Mitt., and *Tanacetum huronense* Nutt. have been explained by Gleason by means of such a migration route.

Although these various migration routes have been most frequently used to explain disjunct distributions among coastal plain species, there is no reason to suppose that other plants, such as *Drepanocladus*, which survived south of the glaciation, did not use the same routes to attain their present widespread boreal distribution. The boggy meadows and shallow pools which formed after the retreat of the ice would have provided especially favorable habitats for the migration of *Drepanocladus*.

b. Survival north of glaciation.—Although relatively little study has been made of the northern border of the continental ice sheets, the general concensus of opinion among geologists is that large parts of northern Alaska and the arctic archipelago were not glaciated during the Pleistocene.

Simmons (1913) states that "the northern [border] seems to have coincided rather closely with the present continental shoreline, with the exception of Boothia Felix and the Melville Peninsula" (p. 153). He discusses the glaciation in the arctic archipelago further as follows:

> The only part of the Arctic Archipelago that shows signs of a considerable former glaciation is southern Baffin Land. . . . The glaciation of [the arctic archipelago] never reached to form large icesheets or continuous inlandices, only isolated glaciers in the valleys and thin icecaps over the summits of some mountains.

Of Alaska, Chamberlain and Salisbury (1907) say:

> . . . mountain glaciation was strongly developed on the ranges adjacent to the Pacific, particularly on the side next to the ocean. On the north side, the ice pushed well out from the high mountains but did not reach the Yukon . . . the plains of Alaska seem to have been free from glaciation even at the stages when the waters of the Ohio and Missouri were being turned from their courses by the encroaching ice sheets 2000 miles farther south.

Not only was the arctic archipelago partly unglaciated during the Pleistocene, but also it was uplifted to form a land continuous with the North American continent. Therefore, there was considerable area north of the continental glacier where plants might have lived during the Pleistocene.

Fernald (1925) was the first to correlate the driftless condition of the arctic archipelago with the fact that plants persisted there during the Pleistocene epoch.

> The Arctic Archipelago during Pleistocene time was uplifted and formed continuous land confluent with the present North American continent; and the consensus of geological opinion is, that it was outside of the area covered by the great glacial fields of North America. Then, as now, it was a region with only local valley-glaciers. Alaska, too, has had only local glaciers and these chiefly at the southern border, where warm and moist winds have favored abundant precipitation. . . . The plants of the Arctic Archipelago . . . are considered, then, to have lived throughout Pleistocene time in the Arctic.

The arid northwestern area of Greenland probably has a climate today similar to that of the arctic archipelago during the Pleistocene. However, that plants exist today in north Greenland, while the rest of the island is ice-covered indicates that plants could have lived in arctic America while that continent was covered with continental glaciers.

When we realize that most of the known modern species of *Drepanocladus*, including all the arctic-alpine species have been found in the partly unglaciated arctic archipelago, it is reasonable to suppose that they inhabited that territory before and during the Pleistocene. The main difference in distribution, both Pleistocene and modern, between the arctic-alpine and boreal-montane species lies in the fact that the latter group also extends far enough southward to persist at the southern border of glaciation. The arctic-alpine species, *D. badius*, *D. brevifolius*, *D. lycopodioides*, and *D. fluitans* var. *Berggreni*, as well as the boreal-montane species, *D. aduncus*, *D. fluitans*, *D. exannulatus*, *D. revolvens*, *D. vernicosus*, and *D. uncinatus* could have survived in the bogs on the northern border of the ice. On the contrary, only the boreal-montane species could have lived in the ponds and swamps at the southern edge of the ice sheets.

As the land was gradually exposed by the melting of the Pleistocene ice, numerous migration routes to the south were opened. The ice probably lingered longest in the central part of the continent, so that the first migration southward was probably along the east and west coasts. This migration along either side of Hudson Bay would form Marie-Victorin's (1938) "rainbow" (p. 547). The boreal-montane species could have migrated along the arms of this rainbow before the routes directly south were opened. The arctic-alpine species never migrated south from their northern refuge.

c. Survival on unglaciated lowlands.—Plants may have survived on an unglaciated coastal plain during the Pleistocene. Although there is little geological evidence either to prove or disprove the existence of such a coastal plain, botanical evidence is so convincing that geologists have accepted it as evidence of a continuous coastal plain during the Pleistocene.

The present sea level is so high that the physical evidence as to conditions along the coast during the Pleistocene has been drowned. By studying the submarine physiography, and calculating the sea level during the Pleistocene, geologists have postulated the extent of this coastal plain. It has been estimated

that with the lowering of the sea level 125 feet, a coastal plain 150 miles wide would have been formed. Johnson (1925) after studying the Gulf of Maine says:

> The submarine physiography demonstrates the presence of a normal, maturely dissected coastal plain bordering the New England-Acadian oldland at a period which would account for the very early migration of the Pine Barren flora [to Newfoundland] . . . instead of a temporary land bridge due to bulging at the margin of the glacier, there was a long-enduring coastal plain topography extending continuously from New Jersey and southward to beyond Newfoundland.

Fernald (1911) in his analysis of the flora of Newfoundland, provided the first and the best botanical evidence of a continuous coastal plain during the Pleistocene. He points out that 118 species of plants belonging to the pine barren and coastal plain floras of New Jersey and the south are known from remote outlying stations along the coastal strip of New England and the Maritime Provinces and that over 7% of the plants of Newfoundland are coastal plain species. Fernald, to explain the similarity of the Newfoundland flora and fauna to that of the Atlantic area of Europe, postulates a migration of biota across the mid-Tertiary land and a subsequent isolation along the northeastern coast of North America. This implies "some tract along the coast, especially of Acadia, and Newfoundland, which held this flora and fauna continuously through the Pleistocene. . ."

That *Drepanocladus* can live in such coastal plain habitats is proved by its occurrence today on the coastal plain of New Jersey and on the plains around the Great Lakes. It seems extremely probable that the boreal-montane species of the genus lived on this coastal plain that is thought to have existed during the entire Pleistocene. The same migration routes that were available to the plants surviving south of the ice sheets would have been opened by the receding ice to these plants on the coastal plain.

Survival within generally glaciated areas.—Fernald, with his Nunatak hypothesis was the first to propose that arctic-alpine plants might have persisted on ice-free lands in the arctic and upon small unglaciated areas (Greenland Eskimo, "nunataks") either within or near the margins of the ice fields.

Fernald studied the alpine tablelands and ravines of the Shickshock Mountains of the Gaspé Peninsula and the Long Range of western Newfoundland and found growing with the characteristic arctic-alpine plants many species which were absent farther north and which were known elsewhere only in the western cordillera, Alaska, or the Altai of Siberia. He correlated this disjunct distribution with the fact that these areas were not glaciated during the Pleistocene. His hypothesis is summarized as follows:

> . . . it is the conclusion of such Canadian geologists as Bell, Chalmers, Coleman, and Alcock, that the Labrador ice-sheets did not cross the Shickshock range and that in the eastern two-thirds of the Gaspé Peninsula glaciation was extremely local, many areas remaining quite free from ice. Analysis of the local distribution on the Peninsula of the Cordilleran and other western plants and of their endemic allies brings out very strikingly the fact that their stations are just exactly on the spots which escaped extreme glaciation. . . .

There has been an active controversy between geologists and botanists about the nunatak hypothesis ever since it was proposed in 1925. The hypothesis does not completely explain many of the relic areas: for instance, those at Bic, Rimouski County, Gaspé Peninsula, Quebec; on the Mingan Islands; and Anticosti. These areas have no actual nunatak areas (or only exceedingly small ones), or were covered by the post-Pleistocene invasion of the Champlain Sea. Furthermore, Flint, Demorest, and Washburn (1941) have shown that the Shickshock Mountains, the best evidence that Fernald had of nunataks, were probably covered with ice during the Pleistocene:

> Detailed search failed to produce any direct evidences of glaciation through the highest 530 feet [on Tabletop Mountain]. Throughout this vertical distance evidences of any possible glaciated surfaces are obscured by mantles of locally derived falsenmeer that presumably originated in post glacial time. In addition, the composition of the bedrock is so heterogeneous that several types of erratics might be present without having been recognized. These circumstances do not demonstrate glaciation of the highest parts of Tabletop Mountain, yet there is no geologic evidence inconsistent with the view that the entire Shickshock highland was overtopped by Wisconsin ice. No geologic evidence was found suggesting that any portion of the area existed as a nunatak during the Wisconsin maximum.
>
> After and probably also before the invasion by Labrador ice, Tabletop, at least, was a center of radial outflow from a local ice cap.

Wynne-Edwards (1939) expresses similar doubt about nunatak areas in eastern North America. He studied a region in southern Baffin Island which is still covered with ice. He found stationary ice fields on the highest ground and concluded that "it may be a fallacy to regard such centres as the Shickshocks of Gaspé as having been ice-free, because they show no evidence of ice-movement." He observed that "the first thing which happens after the retirement of an ice-cap is the almost explosive exfoliation of the surface rock" so that the presence of angular frostbroken fragments of native rock can not be used in support of the existence of nunataks. Furthermore, "Because the rock weathers so fast, many of the visible signs of glaciation are rapidly obliterated, which lends further spurious support to the nunatak theory."

Nevertheless, nunatak areas supporting a considerable flora have been found in modern glaciers. Ostenfeld (1926) has studied a small nunatak area near the north coast of Greenland. A few hardy species are able to live there under conditions which are undoubtedly as severe as those of the glacial period. From the series of nunataks, 54 species of plants were studied; of these 40 were arctic, 3 high arctic, and 11 sub-arctic and boreal.

Until Fernald's nunatak hypothesis is definitely proved or disproved, it is necessary to consider its bearing upon the distribution of *Drepanocladus*. Fernald himself was most interested in the isolated endemics and relics which might have survived on nunataks during the Pleistocene and persist there today. However, there is no reason to suppose that other plants, such as species of *Drepanocladus*, now widespread over the glaciated territory, might not also have survived on those same nunataks and have spread into adjacent territory in post-Pleistocene time.

All the boreal-montane species of Drepanocladus have been found on at least one of Fernald's supposedly unglaciated areas: *D. aduncus* in the Magda-

len Islands and at Bic, Rimouski County, Quebec; *D. exannulatus* on Mt. Albert and Tabletop Mountain in the Gaspé, on the Magdalen and Mingan Islands, and Anticosti; *D. fluitans* on Table Top Mt., Gaspé; *D. revolvens* on Mingan and Anticosti Islands, and Table Top Mt., *D. uncinatus* at Bic, Rimouski County, and Table Top Mt., Gaspé County, Quebec; *D. vernicosus* in the Gaspé Peninsula.

Had *Drepanocladus* survived on numerous nunataks during the Pleistocene, there would have been numerous centers from which dispersal could have taken place after the retreat of the ice.

The Effect of Pleistocene Glaciation Upon Plant Distribution

As a result of Pleistocene glaciation, two types of plant distribution are apparent in boreal regions: (1) relic, static and (2) general, widespread distribution. Whatever hypotheses are proposed to explain post-glacial dispersal of plants must take into consideration these two types of distribution.

Relic distribution.—*Bryoxiphium norvegicum* (Brid.) Mitt. and *Brothera Leana* (Sull.) C. Müll. exemplify one type of relic distribution. According to Steere (1937), wherever *Bryoxiphium* occurs it is on places which seem to have escaped at least the Wisconsin glaciation. It is found south of the maximum extent of glaciation in Kentucky, and Tennessee, comes up to the glacial border in Pennsylvania, Ohio, Indiana, and Missouri, and has been collected on Mt. Rainier, Washington, the driftless areas of Wisconsin and Minnesota, the unglaciated edge of Greenland, and southern border of Iceland. *Brothera Leana* (see Sharp 1939, p. 332 for map) shows a similar distribution: it is found in the south in Tennessee, reaches the glacial border in Pennsylvania and Ohio, and has been collected in the driftless area of Minnesota. This type of relic distribution which extends south of the maximum extent of the glaciation or centers around the driftless area of Wisconsin and Minnesota is found also among flowering plants, for example, *Talinum rugospermum* Holz., *Lespedeza leptostachya* Engelm., *Quercus ellipsoidalis* E. J. Hill.

Another type of relic distribution occurs within the generally glaciated area. Many plants which are widespread in the west occur also in isolated relic colonies in Newfoundland, eastern Canada, and northern New England. Some of the many flowering plants which have this type of relic distribution are: *Danthonia intermedia* Vasey, *Epipactis decipiens* (Hook.) Ames, *Festuca scabrella* Torr., *Habenaria unalascensis* (Spreng.) Watson, *Hordeum boreale* Scrib. & Sm., *Osmorhiza divaricata* Nutt., and *Polygonum Fowleri* Robinson. *Drepanocladus uncinatus* var. *subjulaceus* also shows this type of distribution. It is common in the west with two isolated stations in the Gaspé and Newfoundland.

General widespread distribution.—Both *Bryoxiphium norvegicum* and *Brothera Leana* represent monotypic genera and are stable and well-defined species. *Drepanocladus* and *Calliergon* contrast directly with this condition both as regards distribution and speciation. These two plastic, variable genera, with many poorly delimited species are widespread over the entire glaciated area.

Causes of these types of distribution.—Various theories have been proposed to explain why relic species such as *Bryoxiphium norvegicum* have remained so local in their distribution failing to spread into adjacent country. When Fernald felt that edaphic climatic, and other ecological factors failed to give an explanation he postulated "conservative" or "non-aggressive" species which were able to persist in territory already occupied but which were limited in their ability to pioneer. This emphasizes inherited qualities in the plant rather than external environmental features. Fernald also suggsted that the conservative species were old and senescent, whereas the pioneering species were young and vigorous.

According to Fernald's thesis, then, *Bryoxiphium norvegicum* would be an old species which has passed its period of aggressiveness and is capable today of remaining in established stations, but incapable of spreading. Hence, because of its age, *Bryoxiphium norvegicum* is a stable, well-defined species.

Following this same classification, *Drepanocladus* and *Calliergon* exemplify the other extreme—they are young, aggressive, poorly defined groups. Fernald (1925) says of this type of plant:

> . . . the younger arctic flora which made its way south in eastern America and Europe at least, coincidentally with the advance of the comparatively recent Labradorean or Wisconsin and the later Baltic ice sheets, has not yet had time to set off local species, though in some cases it shows minor variations which are not yet sharply differentiated; and, far from being the rarest and most retiring of relics on our mountains, these young plants, like the young of the human species, are aggressive, dominating, and from mere youthful vigor inclined to crowd out the survivors of a more ancient cycle whose territory they have only recently invaded.

Marie-Victorin (1938) subscribes to this theory of senescence to explain relic species. After studying the phytogeographic problems of eastern Canada he is

> naturally led to concede the senescent condition to the allogenous flora as a whole, to consider the relics as being crowded out by a notable change in the environment, climatic or otherwise, bringing about a strong pressure from the more commonplace elements of the tundra and Spruce forest complexes.

Wynne-Edwards (1939) has found an explanation for the restricted ranges of relic species in soil preferences:

> With few exceptions the rare alpine plants were shown to be basophilic, intimately correlated in their occurrence with the distribution of basic rocks. . . .

Griggs (1940), however, decided that habitat factors do not control the occurrence of rare plants when he found numerous exceptions to known habitat preferences. He cites, for instance, the fact that *Pinus Banksiana* consistently avoids limestone except in the Bruce peninsula where it grows on limestone. Griggs decided, after studying numerous rare plants, that

> the difference between a rare species and a common one lies in the fact that the one fails or almost fails to establish its progeny in the competition for its habitat where the other succeeds in so doing.

The most satisfactory explanations for the occurrence of rare plants and relic species have been found by considering the limiting factors as inherent in the plants themselves rather than in the external conditions. Cain (1940),

in his criticism of the concept of species senescence has postulated satisfactory explanations based on ecological and genetic factors. He states, in part:

> . . . each organism has a certain ecological amplitude. By this expression it is meant that an organism's range of tolerance for different intensities of a certain environmental factor is limited. . . . The plants which compose a species have approximately similar ecological amplitudes . . . it appears that genetic factors control the physiological attributes of a plant just as truly as they control the morphological attributes of the same plant . . . the capacity of a plant to vary physiologically is strictly within the inherited limits just as truly as the plant is limited morphologically by its inheritance. A plant inherits a certain ecological amplitude.
>
> . . . species populations in nature are heterozygous and consist of tremendous numbers of biotypes. Within all large, wide-ranging, species populations, there are geographical partial-populations which differ genetically from other partial-populations. Evolution takes place through the isolation by one means or another of a portion of the large species population. No isolation, no speciation.

He believes that relic species:

> are represented . . . by descendants from mere fragments, peripheral fragments, of the original population. . . . The common lack of colonizing ability . . . would seem to be due to their relatively greater homozygosity and consequent narrower ecological amplitude. . . .

Hultén (1937) found a cause for different genetic constitution of plants in their history during the Pleistocene. His theory was the first to emphasize inherited qualities without carrying with it the idea of age or senescence. In his study of northern vegetation Hultén, after mapping the ranges of hundreds of boreal species, finds that they fall into groups of patterns which are more or less clearly defined geographically and "equiformal." Each equiformal area shows a region of concentration of species which is called its "centre" and from this point of origin each species is assumed to have acquired its present range. The species he calls "radiants" from different "centra."

Hultén correlates the centra, as he finds them, with the distribution of ice during the Pleistocene. He finds no centra in the districts which were covered with ice during the maximum Pleistocene glaciation. Since all the plants radiate from areas that were not completely buried under the ice sheet, he suggests that it was on these "refugia" that boreal plants survived during the Pleistocene.

To explain the differences between plants having (1) relic, static and (2) general, widespread distributions, Hultén postulates some intrinsic differences between the two groups of species calling them "plastic" and "rigid" species. The plastic species are able to migrate freely and invade new territory, whereas the rigid ones have lost their ability to pioneer and adapt themselves to new environments. Hultén does not connect the idea of senescence and age with his rigid species as Fernald does with his conservative species.

Hultén explains how the Pleistocene glaciation may have been responsible for such intrinsic, genetic differences between species:

> Within a given species there is always a certain potential variation. Under the influence of a catastrophe such as the glacial period, when large parts of the area of a species in question are covered with ice and the rest is severely exposed to unfavorable conditions, a reduction of this variation is inevitable, as all biotypes, being more sensi-

tive to hardships are exterminated. . . . A very strong reduction of the biotypes is bound to ensue, and, parallel to it, a strong reduction of the potential variability and thereby also presumably the spreading capacity.

Hultén elaborates on the method by which the Pleistocene glaciation might have effected such a reduction of biotypes as follows:

> That the splitting up of the earlier areas by the ice . . . must have had a very important influence on the number and character of the biotypes remaining in the different elementary areas can hardly be denied. It is evident that the selection of biotypes within the northern elementary areas must be different from that within the southern. When the ice recedes and the plants start to migrate from the isolated spots where they were left, the populations in the different elementary areas must differ in their composition. At any rate, those to the north must differ considerably from the original population which had occupied the same stations during the preceding interglacial. In other words: different races of the species must have been formed under the influence of the ice. As long as those races are separated from one another geographically they may possibly be distinguishable, but when the migration has proceeded so far that the radiants from two elementary areas meet, hybridization and thereby an integradation of the differences must be expected to occur. . . . In some of the areas isolated by the ice the conditions became so severe that certain species could not survive and therefore now show a gap in their distribution there. In other cases the plants in such an isolated area were so depauperated of biotypes that they lost their spreading capacity and are still found only in the stations where they were left by the maximum glaciation. They were thus transformed into rigid species.

Hultén's theory will explain the type of relic distribution of *Bryoxiphium* and *Brothera* as well as the widespread distribution of *Drepanocladus* and *Calliergon*. Only a few biotypes of *Brothera* and *Bryoxiphium* survived the Pleistocene whereas many of the biotypes of *Drepanocladus* and *Calliergon* may have survived. In addition, his classification of rigid and plastic species can be applied to the arctic-alpine and boreal-montane species of *Drepanocladus*. According to Hultén's theory, we can conclude that the arctic-alpine species, *D. badius, D. brevifolius, D. lycopodioides,* and *D. fluitans* var. *Berggreni,* are rigid because relatively few of their biotypes survived Pleistocene. The genetic deficiency accounts for the stability of the species and for their failure to spread from the relic localities where they persist today. We have no indication of the range of the arctic-alpine species in pre-Pleistocene times. If these species extended south from the arctic into boreal regions, then we may conclude that the Pleistocene glaciation may have been responsible for a reduction in their number of biotypes and a consequent reduction in their range. On the other hand, the arctic-alpine species may have always been restricted in their range and variability and the effect of the glacial period may have been merely to intensify an already existent condition of specific rigidity. No evidence today indicates that the arctic-alpine species ever occurred farther south than their present range, as they have never been found south of the arctic either as fossil or living plants. We are, therefore, forced to conclude that these species survived during the Pleistocene in the unglaciated parts of the arctic archipelago. Since only the biotypes adapted to that habitat exist today, the arctic-alpine species are unable to spread into other regions.

Hultén's hypothesis will also explain the existence of a stable, well-defined arctic-alpine var. *Berggreni* in the variable boreal-montane species *D. fluitans*. If only a few biotypes of var. *Berggreni* survived the Pleistocene and if these

were genetically incompatible with the rest of *D. fluitans*, then its present restricted range and stable character could be explained. The facts point to such an explanation. In North America *D. fluitans* var. *Berggreni* has been collected only on Ellesmere Island and the east coast of Greenland. Both of these areas are believed to have been free from ice during the entire Pleistocene. A few biotypes could have survived there producing the rigid population known today as var. *Berggreni*. On the contrary, *D. fluitans* has been collected south of the maximum extent of Pleistocene glaciation in Pennsylvania, West Virginia, Ohio, and New Jersey as well as on the possible nunatak, Tabletop Mountain and over the entire morainal area. *D. fluitans* is the variable, adaptable population we know today because a large number and variety of biotypes survived in numerous different habitats.

A parallel condition is found among the flowering plants in *Iris setosa*. Alaskan plants of *Iris setosa* are highly polymorphic, whereas an eastern group (var. *canadensis* Foster), isolated around the Gulf of St. Lawrence, is remarkably uniform. Anderson (1936) discusses this condition as follows:

> The variation within *Iris setosa* var. *canadensis* seems particularly instructive in the light of its recent history. . . . In Alaska a large central region was left unglaciated; around the Gulf of St. Lawrence, on the other hand, the plant refuges in glacial times were little more than rocky nunataks rising above the ice. The results on the two sets of irises are just what a geneticist might predict. Even from the few specimens which are available in herbaria one can see that the *Iris setosae* of Alaska are a varied assemblage. . . . The irises of eastern Canada present a very different picture. . . . Compared to the millions of irises which might well have continued to live in Alaska during the ice age, those of the St. Lawrence were a mere handful. From that handful must have descended the millions upon millions of irises which now carpet the meadows and shores of that region. . . . Compared with our other American blue flags they are a singularly invariable lot. . . .
>
> This conservatism of *Iris setosa* var. *canadensis* is distinctive of most of the glacial endemics (or near endemics) of the region around the Gulf of St. Lawrence. . . . In the case of *Iris setosa* var. *canadensis* the invariability cannot be a direct effect of time, for the highly variable irises of Alaska are quite as aged. It is more probably . . . an innate conservatism; a conservatism founded genetically upon the fact that these irises are descendants of a small and highly selected stock. Hard times removed from the region all the luxuriant types which may once have existed there. When the ice age was over the immediate area was repeopled from the few plucky survivors. Their descendants, *Iris setosa* var. *canadensis*, bear the scars of the glacial period, so to speak, in their conservatism; an innate invariability which, on the one hand, gives them a greater uniformity, and on the other, prevents their adapting themselves readily to other environments.

The range of *D. uncinatus* var. *symmetricus* which is confined to the western mountains of America can also be explained by Hultén's rigid species resulting from selection during the Pleistocene. Evidently only the biotypes suited to the habitats of the western mountains survived the glaciation thus producing a variety confined to that geographical region today.

The boreal-montane species, *D. revolvens*, *D. aduncus*, *D. fluitans*, *D. exannulatus*, *D. vernicosus*, and *D. uncinatus* are variable or plastic because a large number of biotypes survived the Pleistocene in a large number of areas and in a great variety of habitats. Evidence points to the conclusion that the boreal-montane species survived during the Pleistocene in all of the possible locations: (1) south of the maximum extent of the glaciation in such localities

as Lancaster County, Pennsylvania, Perry and Liberty Counties, Ohio, the Ozarks of Missouri, and Pocahontas and Preston Counties, West Virginia; (2) in the unglaciated parts of the arctic archipelago; (3) on the coastal plain in such habitats as the pine barrens of New Jersey; and (4) on unglaciated nunataks such as Tabletop Mountain and Mt. Albert in the Gaspé. The resultant genetic constitution of the boreal-montane species accounts for their variability and ability to spread into all favorable habitats. Fossil evidence shows that these boreal-montane species were as widespread during the interglacial periods (and perhaps before the Pleistocene) as they are today. It is evident, then, that there were a large number of biotypes which could have survived in unglaciated areas during the Pleistocene. In studying fossil *Drepanocladi* that have been deposited in Iowa, Minnesota, and California, it is apparent that some of the species, *D. aduncus, D. fluitans, D. revolvens,* and *D. exannulatus,* have remained unchanged since the first interglacial period. These fossil plants are so similar to plants of modern age that they have been assigned to the same varieties. Other species, *D. minnesotensis* and *D. apiculatus,* now extinct, were unable to survive, and succumbed to the vicissitudes of the Pleistocene.

In conclusion, according to the best hypotheses, the present wide distribution of *Drepanocladus* in boreal America is dependent upon the variability and adaptability of the species, and these, in turn, are dependent upon the number and variety of biotypes that survived the Pleistocene epoch.

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Unusual North American Agarics[1]

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The problem of identifying agaric collections is all too frequently complicated by incomplete or erroneous data on the described species, and the investigator who is without access to authentic material finds it impossible to carry on satisfactory studies in this group. Such a situation defeats the purpose for which our botanical publications exist. It follows, then, that as more information is accumulated on any such previously incompletely known species it should be presented to the scientific public in the most useful as well as the briefest manner possible. In deciding upon the best method of accomplishing this objective, a rather obvious and simple principle was followed. During the course of many years of studying the European species as they occur in the agaric flora of North America, ample opportunity was encountered to compare the usefulness of the information given by various authors, and to compare the methods they used to present it. Invariably one method stood out from all the others. This was the presentation of a detailed description drawn from the specimens collected.

The group of French agaricologists, who were so active in the two decades before the present world conflict engulfed them, for the most part followed this procedure, and as a result their writings have been eminently useful. A detailed description allows the user to judge for himself whether or not the author's identification is correct and further allows him to interpret his own data much more accurately than would be the case if he had only the original description of the species in question plus scattered comments by other authors from which to draw conclusions. In addition, this procedure, better than any other, answers the questions of future investigators who may be approaching the problems of classification from a radically changed viewpoint, and who may have reason to place great emphasis on some character noted but not considered important by the earlier worker. Because this method of presenting information on agarics has withstood the test of usability as applied to the work of others, it is the one I have adopted here.

The species redescribed in this paper are very rare or were previously unknown in North America and complete data on them are needed to make the reports usable to other workers. Some, such as *Clitocybe maxima*, have been erroneously reported by earlier workers. In all, twenty-three species have been redescribed: thirteen in Clitocybe, five in Tricholoma and one each in Amanita, Flammula, Hebeloma, Omphalia and Pholiota. Most of the material was collected on the Olympic Peninsula of Washington during the fall of 1941. The color names within quotation marks have been taken from R. Ridgeway, *Color Standards and Color Nomenclature*, Washington, D.C. 1912.

[1] Papers from the University of Michigan Herbarium.

The collections have all been deposited in the University of Michigan Herbarium.

CLITOCYBE CERUSSATA var. DIFFORMIS Schum. *sensu* Bresadola, Icon. Myc. 3: pl. 143, 1928.

Pileus 3-8 cm. broad, nearly plane but with an inrolled margin, becoming plane or developing a shallowly depressed disc in age, the margin spreading or arched and often conspicuously crenate-lobed, surface white to pale ashy white, glabrous, appearing appressed fibrillose under a lens, sometimes with watery-gray spots around the disc; flesh thin, about 2 mm. thick at the stipe, slightly tapered to the margin, pallid ("tilleul buff") and watery, unchanging when cut or bruised, odor and taste not distinctive; lamellae short-decurrent, moderately broad (up to 7 mm.), broadest at the base and tapered to the margin, close but not crowded, 50-70 reach the stipe, 4 tiers of lamellulae, pallid ("tilleul buff") or even a little darker when young, whiter in age, edges somewhat undulating; stipe 4-7 cm. long, 8-10 mm. thick at the apex, solid but becoming hollow, cortex pallid, surface dull white and more or less appressed cottony-fibrillose, apex more or less fibrillose-pruinose.

Spores 5-5.5 x 3μ, ellipsoid, smooth, hyaline, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama of narrow interwoven hyphae, not amyloid; pileus trama homogeneous, not amyloid, the surface layer slightly gelatinous in KOH but not forming a truly gelatinous pellicle, the hyphae not appreciably thinner than those of the rest of the trama, clamp connections present.

Gregarious to cespitose on grassy ground under alder, Joyce, Wash., Sept. 29, 1941 (17,397) and in mixed conifer and alder forests, Elwah Dam, Olympic Mountains, Wash., Oct. 2, 1941 (17,540).

Observations: I was at first inclined to place these collections in *Clitocybe variabilis* Murrill, but Singer's (1942) account of the type specimens makes such a disposition untenable. The gills are neither narrow nor subdistant and no variation in spore size has been found between large and small pilei. From Murrill's original description and from Singer's study of the type one cannot help wondering whether or not Murrill's species is a mixture of *C. cerussata* and some other white Clitocybe.

C. cerussata var. *difformis* is variously described by European authors. If one attempts to make very exact comparisons between their descriptions, secondary differences can be found to distinguish them from each other. In my estimation they are merely differences between collections. The lobed pileus and tendency to grow in clusters appear to be the primary characters by which the variety is recognized.

Both the typical variety and variety *difformis* have been reported previously from North America, but Kauffman did not recognize the latter in his key (1927). He also questionably referred *Clitocybe Overholtsii* to *C. cerussata* as a synonym. Singer (1942) in his recent study of the type of the former has placed it in synonymy with *C. nebularis*.

CLITOCYBE CERUSSATA var. PITHYOPHILA (Fries) Lange *sensu* Lange in Fl. Agar. Dan. 1: 79, pl. 36, fig. E. 1935.

Pileus 4-7.5 cm. broad, broadly convex to nearly plane, the margin inrolled, plane in age or the margin arched slightly and a bit fibrillose, glistening somewhat but not viscid, becoming pallid or sordid where fibrils are rubbed off; flesh moderately thick, 4-6 mm. at the stipe, tapered evenly to the margin, watery-pallid, becoming whitish (near "pinkish buff" in some), pliant, unchanging when bruised, odor and taste not distinctive; lamellae crowded, 46-52 reach the stipe, 3-4 tiers of lamellulae, narrow to moderately broad (4-5 mm.), bluntly adnate and becoming short-decurrent, broadest next to the stipe and tapered slightly to the margin, pallid when young ("tilleul buff") and in age becoming a pale sordid buff; stipe 5-7 cm. long, 5-7 (8) mm. thick, equal, terete, flexuous or straight, base densely white cottony-fibrillose and with a white fluffy mycelium throughout the surrounding debris, faintly white-fibrillose upward, apex nearly glabrous or merely silky, whitish but the pale buff ground color becoming more evident in age.

Spores 4-4.5 x 2.7-3 μ, subglobose to very broadly ellipsoid, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama not amyloid, of interwoven hyphae 5-10 μ in dia.; pileus trama homogeneous beneath a poorly differentiated pellicle of narrow interwoven hyphae 3-5 μ in dia., hyphae of the flesh proper 6-12 μ in dia.

Gregarious under mixed alder and conifers, Port Ludlow, Wash., Oct. 13, 1941 (17,825) and under second growth fir, Chimacum, Wash. also on Oct. 13 (17,831).

Observations: The concept adopted here is that of Lange. His description and illustration clearly represent the species collected in the Olympics. This concept differs from that of Kauffman and others particularly as regards spore size. Kauffman (1927) considered Murrill's *Clytocybe subconnexa* as a synonym of *C. pithyophila* but he apparently did not examine the spores of the type. Singer has studied the type and found the spores to be rough instead of smooth, and placed the species in the *inversa*-group. Consequently Kauffman's synonymy must be disregarded. However, if Murrill's original description was actually drawn from the specimen now preserved as the type, it is difficult to visualize any close relationship to *C. inversa*. It seems more likely that *C. subconnexa* is the same as *C. connata* (Fr.) Gillet, sensu Konrad & Maublanc (1924-33). For further discussion see *C. subconnexa* p. 680.

CLITOCYBE CONCAVA (Fries) Gillet, Champ. Fr. 150. 1878.

Pileus 3-6 (7) cm. broad, convex with a somewhat flattened disc at first, the margin soon plane and wavy or undulating and the disc deeply and sharply depressed, at times the depression almost tubular, surface glabrous, moist, lubricous, margin at times faintly striatulate, color "mummy brown" to "buffy brown" moist (an olivaceous grayish brown), hygrophanous, fading to "tilleul buff" or "olive-buff" (pallid to olive-grayish), fading on the disc first; flesh conocolorous with surface, thin, tough, odor and taste not distinctive;

lamellae close or in large caps nearly subdistant; decurrent, narrow, "drab" (dark grayish) or pale grayish brown; edges even; stipe 3-4 (5) cm. long, 3-5 mm. thick, equal, base densely white mycelioid and usually with much adhering debris, tubular or compressed, surface more or less glabrous, concolorous or paler than the pileus, usually rather tough and pliant.

Spores 5.5-7 x 3-4 μ, ellipsoid, smooth, not amyloid; basidia four-spored; pleurocystidia and cheilocystidia not differentiated; gill trama not amyloid, of narrow more or less interwoven hyphae; pileus trama homogeneous, not amyloid, hyphae of the cuticle interwoven, subgelatinous in KOH and more or less the same thickness as those of the flesh proper.

Gregarious in large troops under spruce, Smith River, Calif., Nov. 16, 1937 (8757); Cave Junction, Ore., Nov. 29 (8192) and Dec. 1 (9326), around an old log under yellow pine; Olympic Hot Springs, Olympics, Wash., Oct. 8, 1941 (17,667).

Observations: The species Kauffman (1927) placed in *C. concava* is one of the forms of *C. cyathiformis*, and cannot be referred to *C. concava* as illustrated by Fries (1867), Bresadola (1928) or Konrad & Maublanc (1924-33). In the confusion of names which surrounds this species it appeared best to use the name for which the concept has been clearly established, and which is consistent with Fries' later work. Murrill (1916) used the name *C. concava* for the species now commonly known under the name *C. cyathiformis*. The latter fungus and its various forms usually occur on decaying wood, have larger spores and a somewhat different color—one in which olive is lacking. According to my collecting experience, *C. concava* fruits prolifically during the warm wet weather between frosts in late autumn.

CLITOCYBE FELLEA Peck, Ann. Rept. N. Y. State Mus. **51**: 284. 1898.

Pileus 2.5-7 cm. broad, flat or shallowly depressed when young, the margin inrolled, becoming either plane or broadly vase-shaped (the disc deeply depressed and the margin elevated), margin thin and splitting readily in age, faintly striatulate when water-soaked, surface dry and minutely fibrillose-furfuraceous to scaly (especially in the depression), color "Sayal brown" to "cinnamon" or "pinkish buff," darker when young and paler in age (sordid tan to yellowish), not hygrophanous; flesh thin (1-1.5 mm.), white to watery whitish, pliant, taste very bitter and disagreeable, odor strongly fungoid to subnauseous when flesh is crushed, no color change when bruised or cut; lamellae close to crowded, 27-60 decurrent on the stipe, 3-5 tiers of lamellulae, some forked near the stipe, long-decurrent in age, narrow and equal (2-3 mm.), white to pallid ("tilleul buff"), edges even; stipe (2.5) 4-7 cm. long, 5-8 mm. thick, solid, equal above a fibrous mycelioid base, pliant-fleshy, surface pallid or more or less concolorous with the faded pileus, faintly appressed silky-fibrillose but glabrescent, usually with scattered rhizomorphs and much debris attached to the base.

Spores pear-shaped or drop-shaped and with a curved apiculus, 7-8.5 x 3.5-4 μ, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia none; gill trama not amyloid, hyphae 6-10 μ broad, interwoven; pileus trama homo-

geneous, not amyloid, clamp connections present, a few undifferentiated hyphae projecting 18-38 μ from the surface as pilocystidia.

Scattered under spruce, Forks, Wash., June 18, 1939 (14,427) and on soil along a road, Hurricane Ridge, Olympic National Park, Wash., July 7, 1939 (14,859).

This appears to be a rare species, but one well characterized by the minutely scaly, pale yellowish brown pileus, pallid lamellae and very disagreeable, bitter taste. The Olympic Mountain collection contained larger pilei than indicated for the species by Peck, and their gills were not subdistant. However, these characters appear to be quite variable. In no. 14,859 the carpophores were more as Peck (1898) illustrated them. The gill attachment was slightly decurrent and the spacing almost subdistant. In the larger pilei of no. 14,427 the characters were as given in the description. The latter was drawn from this collection.

Kauffman (1927) described var. *glabreosa* of *C. fellea* and also a closely related species which he designated as *C. felleoides*. Both type collections have been examined. The spores of both are 6-8 (9) x 3-4 (5) μ, smooth and amyloid. Filamentous scattered cheilocystidia 23-36 x 3-4 μ are present. The hyphae of the cuticle of the pileus are 3-4 μ in diameter and are slightly encrusted. Clamp connections are present and neither the gill nor pileus trama are amyloid. Since both collections are obviously the same fungus, and since the species is very distinct from *C. fellea* both in gill color and in the iodine reactions of the spores, *C. fellea* var. *glabreosa* becomes a synonym of *C. felleoides* Kauff. *C. felleoides* belongs to that group of Omphalia-like species of Clitocybe having amyloid spores. The taxonomic position of these species is as yet rather uncertain. Singer (1942) placed them tentatively in Xeromphalina.

CLITOCYBE INORNATA (Fries) Gillet, Champ. Fr. 155. 1878.

Pileus 4-9 cm. broad, at first broadly convex with an inrolled margin, soon plane or the margin slightly arched or elevated, often wavy and lobed in age, surface dry and evenly covered by a thin coating of appressed cottony fibrils which give it an evenly pallid ("tilleul buff") color at first, no separable pellicle present, slowly glabrescent and becoming a dull sordid brown ("buffy brown" to nearly "drab"—dark grayish brown) either in spots or over all, the canescent fibrillose coating persisting along the more or less tomentose margin, the surface occasionally marbled with watery spots; flesh soft and buttery, watery gray but fading to tilleul buff, odor none, taste faintly but quickly bitterish, soon mild, no color change when cut or bruised; lamellae readily separable from the pileus, close 52-58 reach the stipe, 1-3 tiers of lamellulae, moderately broad (5-6 mm.) nearly equal, slightly adnexed, bluntly adnate or short decurrent, many forked near the base, pallid, cinereous to dull pale drab, edges even and whitish; stipe 5-8 cm. long, 10-15 mm. thick, equal or slightly enlarged below, solid, fleshy, (spongy when wet), grayish within, exterior whitish from a canescent coating like that of the pileus, more or less glabrescent and then sordid or pale drab-gray, base surrounded by a spongy mass of whitish gray mycelium and scattered white rhizomorphs.

PLATE 1, *Clitocybe inornata* (FR.) Gillet

Spores 7-9 (10) x 3-4 μ, tapered to either end and subventricose (hence somewhat fusiform), smooth, not amyloid; basidia four-spored, 28-36 x 5-6 μ; pleuro- and cheilocystidia not differentiated; gill trama of interwoven hyphae, not amyloid; pileus trama homogeneous, not amyloid, cuticle of loosely interwoven hyphae 5-7 μ in dia., tramal body of compactly interwoven hyphae of about the same thickness, clamp connections present.

In arcs in low wet woods of beech, oak, ash, and elm, Kent Lake, Oakland County, Michigan, Nov. 1, 1940 (15,526); Milford, Mich., Nov. 5, 1940 (15,545). An earlier collection from Warrensburg, N. Y. was made Sept. 15, 1934, (1054) but no notes were taken.

Observations: The material from Warrensburg dried slightly more alutaceous than did the Michigan specimens, but this may have been caused by the method of drying used on each. The New York material was dried over an open flame whereas that from Michigan was placed on an electric drier. Although well characterized in the European literature, see Lange, Bresadola, and Konrad & Maublanc, little is known of the species in North America. Kauffman (1927) did not include it among the known North American species in his key. It apparently is not among any of the numerous species described by Murrill. The unpolished gray pileus, pale drab gills, and subfusiform spores along with the somewhat tricholomoid stature are distinctive. Singer (1942) has pointed out that the spores of the types of *Clitocybe avellaneialba* Murr., *Tricholoma latum* Pk., *Melanoleuca avellanea* Murr., and *C. mexicana* Murr. are about 10 x 4 μ and that these species are in the *inornata*-group. They can apparently be distinguished from *C. inornata* by their paler lamellae. In my own study of the type of *Tricholoma avellaneum* Murr. the spores were found to be ellipsoid or slightly curved on the inner side, but not fusoid, and it appeared to me that there was some likelihood of the species being a synonym of *Clitocybe nebularis*.

CLITOCYBE MAXIMA (Fries) Quélet, Champ. Jura et Vosges: 88. 1872.

Pileus (7) 9-20 (30) cm broad, with a slightly depressed disc and an inrolled margin when young, some with a small abrupt umbo in the center of the depression, expanding and becoming both broadly and deeply infundibuliform, the margin remaining inrolled until late maturity, in extreme age the margin often wavy and flaccid, either regular in outline or sinuate and lobed, surface appearing glabrous only when wet, soon dry and unpolished to more or less fibrillose-furfuraceous in the depression, margin cottony and occasionally ribbed, sometimes watery-spotted, color "pinkish buff" to "light pinkish cinnamon" (very pale tan with a tinge of pink), color fading in age; flesh about 5 mm. thick near the stipe, tapered abruptly away from the umbo and then evenly so to the margin, very firm and rigid at first but more or less flabby in age, white, not watery, odor and taste not distinctive; lamellae close but not crowded, about 50 decurrent on the stipe, 3-4 tiers of lamellulae, many lamellulae forked near the stipe, and again midway to margin, long and unequally decurrent, narrow (3-5 mm.), not readily separable from the pileus; stipe 9-15 cm. lonog, 18-30 mm. thick at the apex, clavate (base 35-40 mm.), solid and white within, surface whitish, glabrous but soon more or less fibrillose

PLATE 1, *Clitocybe inornata* (Fr.) Gillet

from the manner in which the cuticle splits into shreds, frequently deeply longitudinally striate, white mycelium and rhizomorphis surrounding the base.

Spores 7-8 (9) x 5-6 μ, ellipsoid to broadly ovoid, smooth, not amyloid; basidia four-spored; 40-48 x 7-8 μ; pleuro- and cheilocystidia not differentiated; gill trama of interwoven cells 5-8 μ in dia., not amyloid, subhymenium very thin; pileus trama not amyloid, homogenous beneath a cuticle composed of interwoven hyphae 4-8 μ in dia., many hyphal end-cells projecting or somewhat decumbent, pigment located in the threads of the cuticle; clamp connections present on white mycelium at base of stipe.

Gregarious under alder, Wolf Creek, Lake Mills, Olympic Mountains, Wash., H. V. Smith, Sept. 25, 1941 (A.H.S. 17,243); same locality Sept. 27, D. E. Stuntz and A. H. Smith 17,335; Altaire Forest Camp, Elwha River, Olympics, Wash., Oct. 2 (17,489); Wolf Creek, Oct. 4, 1941 (17,885).

Observations: Konrad & Maublanc (1924-33) consider *C. maxima* to be a variety of *C. geotropa*. Both *C. geotropa* and *C. maxima* have been reported from North America, but it is difficult to learn much about either fungus from these reports. As Singer and Smith (1943) have pointed out, Kauffman's concept of *C. maxima* was erroneous, being based on *Leucopaxillus tricolor* (Pk.) Kühner. Bresadola (1928) distinguished *C. geotropa* from *C. maxima* by its rough spores and also by a distinct difference in their shape. The Olympic Mountain collections are unquestionably the fungus described by Bresadola as *C. maxima* and since his concept is closely in line with that of Fries it has been accepted. There can be no questioning the very close relationship between *Clitocybe infundibuliformis* and the fungus here identified as *C. maxima*. In fact, the latter might be considered as merely a gigantic form of *C. infundibuliformis*. Fries (1874) arranged these two beside each other in recognition of this similarity.

CLITOCYBE OLIDA (Quélet) Konrad, Bull. Soc. Myc. Fr. **45**: 60. 1929.

?*Cantharellus Morgani* Pk., Bot. Gaz. **7**:43. 1882.
?*Cantharellus rosellus* Pk., Ann. Rep. N. Y. State Mus. **42**:120. 1889.

Pileus 1-2 (3.5) cm. broad, the disc sharply depressed, the margin arched and nearly always sinuate or lobed, sometimes spathulate, surface minutely fibrillose and when wet somewhat viscid to the touch (as in *Inocybe geophylla*), color "light vinaceous cinnamon" in the depression, "pale pinkish buff" along the margin, at times becoming almost "flesh-ocher" over all (pallid buff along the margin, disc tinged pinkish cinnamon, becoming pinkish red over all in age); flesh pallid, very thin and pliant, odor very sharply fragrant and resembling that of cinnamon candy but very faint at times, taste sharp but soon mild (hard to distinguish because of the odor); lamellae crowded, very narrow, repeatedly forked, somewhat foldlike with obtuse edges, long-decurrent, "light buff" or paler, slightly crenulate; stipe 2.5-3.5 cm. long, 2-3.5 mm. wide at apex (often flattened), narrowed evenly to a pointed base, solid, concolorous with the pileus or duller, very finely pruinose-fibrillose but in age merely unpolished.

Spores ellipsoiid, 3-4.5 x 2.5-3 μ, smooth but sometimes appearing slightly

punctate under an oil immersion lens, not amyloid (remaining hyaline in some mounts, in others with a slight greenish cast); basidia four-spored, 30-40 x 4-5 μ; pleurocystidia and cheilocystidia not differentiated; gill trama not amyloid, of very loosely interwoven to subdivergent hyphae 4-6 μ in dia.; pileus trama floccose, cells 4-8 μ, not amyloid, clamp connections abundant.

Scattered to gregarious under Douglas fir, ponderosa and lodgepole pine, in Washington and Oregon. Storm King Mt., Olympic National Park, Wash., Oct. 20 (18,114); just east of McKenzie Pass, Ore., Oct. 29 (18,161); Lost Creek, Ore., Oct. 30 (18,211); Santiam River (the head waters), Ore., Oct. 31 (18,301); Ochocho National Forest, Ore., Nov. 7, and Mt. Hood, Ore., Oct. 28, 1941 (18,302).

Observations: The fragrant odor characteristic of this species is sometimes faint and easily missed at the time a collection is made. It becomes stronger after the specimens have been gathered, but soon vanishes after the carpophores have been placed on the drier. The spores are so small that the markings on the walls are very difficult to make out under the highest magnifications. The gills are often so crowded, particularly in young pilei, that one gets the impression that the hymenium is smooth. Although the gill edges are obtuse, the fungus is placed in Clitocybe by present day European mycologists. Konrad & Maublanc (1924-33) show the irregular character of the pileus very well. The color apparently varies considerably depending on the age of the specimens at the time they are collected. Dr. Rolf Singer, to whom specimens were submitted for confirmation, reported that aside from the redder color, my material was identical with *C. olida* as he found the latter in Europe. The name *Cantharellus rufescens* which Quélet (Cooke and Quelet, 1878) gave to this species significantly emphasizes the changing color. Quélet also pointed out that the odor developed as the specimens dried. This is in direct contrast to my observations and appears to be indicative of the irregularity of this character.

To judge by the descriptions, both *Cantharellus rosellus* Pk. and *Cantharellus Morgani* Pk. are synonyms of *C. olida*. A fragrant odor is not described for either species, but, since neither is at all well known, it is likely that our information is incomplete. The differences between the two descriptions of Peck can be readily interpreted as the expected variation between different collections of a single species. I have not had an opportunity to compare my material with Peck's types.

CLITOCYBE REGULARIS Peck, Bull. N. Y. State Mus. 10:948. 1902.

Pileus 4-8 cm. broad, plane or slightly umbonate at first, the margin inrolled, expanding to plane or the margin uplifted somewhat, the disc remaining flat or slightly umbonate, the margin finally wavy or plicate, surface dry and white at first from a canescent, thin fibrillose covering, subglabrescent in age and then sordid pinkish buff or watery buff (much as in *C. dealbata*); flesh thick, very soft and flabby, odor and taste none; lamellae long-decurrent, crowded, white but in age becoming sordid buff, narrow, not readily separable; stipe 6-8 cm. long, 8-13 mm. thick at apex, somewhat enlarged downward,

base with numerous white rhizomorphs and entire lower portion covered by a dense mass of cottony mycelium giving it a felty-spongy appearance, stuffed but becoming hollow, whitish near the apex, dull incarnate watery tan below.

Spores 4-5 x 3-3.5 μ, smooth, broadly ellipsoid, not amyloid; basidia four-spored; pleurocystidia and cheilocystidia none; gill trama more or less interwoven, not amyloid; pileus trama not amyloid, homogeneous, hyphae near surface slightly narrower than in central part, cuticle not differentiated, the hyphae over the surface merely more compactly arranged than in the tramal body, interwoven, clamp connections present.

In arcs under Douglas fir, Blue River, Ore., Oct. 16, 1937 (7864); Smith River, Calif., Nov. 19 (8888), under spruce; Kirby, Ore., Nov. 26, 1937 (9139), under pine.

Observations: The spores, spongy mycelioid base of the stipe and white color of the pileus when young serve to distinguish this Clitocybe. The large size of the Blue River specimens might lead some to regard them as a distinct form, but such differences are encountered so frequently between eastern and western representatives of many species that they do not appear to merit much emphasis. In certain characters such as lack of an anise-like odor and taste, my material is similar to var. *insistens* Kauff. I did not observe the colors to become as brownish as described by Kauffman, however, and the gills were white at first. These differences clearly indicate that my western collections are intermediate between the two. The spongy mycelioid base of the stipe, however, appears to be a reliable character by which the species can be readily distinguished from its near relatives such as *C. cerussata.*

CLITOCYBE SINOPICA (Fries) Quélet, Champ. Jura and Vosges supp. 3: 450. 1875.

Clitocybe sinopicoides Peck, Bull. N. Y. State Mus. **157**:80. 1912.

Pileus 2-4 cm. broad, convex when young, soon becoming depressed on the disc but not deeply so, margin incurved at first, surface dry and minutely appressed-fibrillose near the margin, minutely scaly in the depression due to the breaking up of the thin fibrillose cuticle, margin sometimes wavy but usually not strongly elevated, color "liver brown" to "Kaiser brown" or the disc a little darker (deep brick red to reddish brown) slowly becoming paler reddish in age; flesh thin, hardly tapered, whitish or tinged watery vinaceous, odor and taste strongly farinaceous; lamellae close, 38 $\pm$ reach the stipe, 2-3 tiers of lamellulae, broad (3-4 mm.), short-decurrent, "tilleul buff" young, somewhat cream-colored in age, edges even; stipe 3-5 cm. long, 5-7 mm. thick, central or eccentric, fleshy, hollow, pallid within, equal or sometimes flared at the apex, surface appressed fibrillose-striate with "hazel" (bright ferruginous) fibrils or glabrous and "hazel" over all, base with scattered white rhizomorphs.

Spores broadly ellipsoid, 7-9 x 4-6.5 μ, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia none; gill trama not amyloid, of narrow somewhat interwoven hyphae; pileus trama not amyloid, surface hypae equal in thickness to those of the flesh, interwoven and with numerous clamp connections.

Scattered on soil in a burned area, Lake Crescent, Olympic Mountains, Wash., June 9, 1939 (14,213).

Observations: Without question this is the *C. sinopica* of Europe. Lange (1935), Bresadola (1928) and Konrad & Maublanc (1924-33) all give the spores as 7-9 (10) x 5-6 (6-5) μ. Peck distinguished his *C. sinopicoides* from *C. sinopica* by its narrower (3-4 μ) spores which were only 6-8 μ long. Murrill (1916) placed Peck's species in synonymy with *C. sinopica* and Kauffman (1927) reestablished it adding that the spores of *C. sinopicoides* were "punctate-rough." Kauffman apparently did not examine the type but instead based his information on excellent material collected by himself. I have examined the spores of this collection and found them to be smooth instead of rough as Kauffman described them. Thus the relationship of the two species must be reconsidered. The spores of Kauffman's collection measured 6-8.5 x 4-5.5 μ. In addition to no. 14,213, I have several other collections from Washington and one from Michigan all with spores 7-9 x 4-5.5 μ. No significant differences in other characters were noted for these collections. The differences in spore size appear to me to be within the expected range of variation for the species, and not taxonomically significant. Consequently *C. sinopicoides* should be regarded as a synonym of *C. sinopica* unless an examination of the type reveals some character not ascertainable from the descriptions. I have not had an opportunity to examine the type.

Métrod (1939) has found the small spored form in Europe and given it the name *C. sinopica* var. *microspora*. This situation appears to be parallel with that of *Leucopaxillus giganteus*, see Singer and Smith (1943), only in the Clitocybe the small spored form is now known in both Europe and America and so cannot be regarded as even a distinct geographic race. Arnold (1935) in her study of *Marasmius elongatipes* Pk. found similar races, distinguished by a difference in spore size, to be interfertile.

CLITOCYBE RHIZOPHORA (Vel.) Josserand, Bull. Soc. Linn. Lyon, 7: 148-149. 1938.

Collybia rhizophora Vel., Ceské Houby 335. 1920-22.
Clitocybe verna Eglund in Lundell, Svensk Bot. Tidskrift **31**:190. 1937.

Pileus (1) 3-5 (6) cm. broad, nearly flat when young, soon becoming sharply depressed and with a spreading or elevated margin, in age finally subinfundibuliform, glabrous, lubricous when moist, the margin sometimes striatulate and in age often crenate or wavy, subhygrophanous, "Saccardo's umber" to "Isabella color" moist, becoming pale sordid grayish brown ("avellaneous" to "wood brown"), fading to fairly dark or light sordid yellowish brown, or near avellaneous; flesh thin, 1 mm. $\pm$ thick, rather cartilaginous-pliant, concolorous with pileus either when moist or faded, taste slightly disagreeable but hardly bitter, odor none; lamellae close (25) 30-40 (60) reach the stipe, 3 tiers of lamellulae, narrow to moderately broad (3 mm. $\pm$ in age), adnate at first but soon short decurrent, whitish becoming pale buff ("pinkish buff") or sometimes nearly "buffy brown" (but with less olive), evenly colored, edges even; stipe 2-4 cm. long, 2-4 mm. thick at apex, equal or enlarged slightly below, stuffed with a pallid pith, cortex concolorous with the pileus, rather

tough but fleshy rather than cartilaginous, surface glabrous or fibrous-striate, sometimes with numerous fibrillose points roughening the apex, the base with many projecting white rhizomorphs holding debris together in a mass.

Spores 5-7 x 2.5-3.5 μ, ellipsoid, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama of narrow interwoven hyphae, not amyloid, pileus trama homogeneous, not amyloid, the hyphae, over the surface more or less interwoven and with subgelatinous walls, not organized into a true pellicle.

Gregarious under black spruce, Whitmore Lake, Mich., May 29, 1935, (1277); L. R. Hesler, no. 11,425, New Hopewell, Knox County, Tenn., May 26, 1938; Lake Ozette, Wash., May 15, 1939 (13,417); Heart o' Hills, Mt. Angeles, Olympic Mountains, Wash., June 19, 1939 (14,446) and June 28 (14,670); Boulder Lake Trail (7000 ft. $\pm$) McCall, Idaho, July 31, 1941 (15,850).

Observations: I first identified my collections as *C. vermicularis*, thinking that perhaps the difference in color had been caused by local environmental conditions. However, the continued appearance of this species in various parts of the country and always with the same dull colors is sufficient proof that the difference is significant. *C. vermicularis* must, and in general has been, regarded as a distinctly reddish species at least in its young stages. Kauffman (1927) described *C. vermicularis* f. *cystidiosa* as having slender pleurocystidia and pointed out that these organs may have been overlooked by other investigators. In other words, Kauffman considered it likely that f. *cystidiosa* was actually not distinct from the typical form, but had no evidence to support his opinion, and so selected this means of emphasizing the character.

According to Lundell *C. verna* is sometimes found very early in the year; he cites one collection in January. It is likely that along our west coast similar early occurrences will be recorded eventually. Although collected in late July, the Idaho material, because of the altitude at which it was found, is not inconsistent with the vernal appearance of the species. My collections were characterized by a tendency of the gills to darken in age, but it was variable and so no particular emphasis is placed upon it. In all other respects Lundell's account covers the American material very well.

CLITOCYBE SUBCONNEXA Murrill, Mycologia 7:272. 1915.

Pileus 3-6 cm. broad, convex with an incurved margin when young, in age plane or with a slightly depressed disc, the margin usually remaining decurved, snow-white over all, opaque and with a satiny lustre from a dense coating of appressed fibrils, occasionally with a few watery spots around the disc, glabrous to the naked eye, not hygrophanous; flesh white, thick on the disc, thin on the margin, taste slightly bitterish, odor faintly fragrant to merely fungoid, no color changes when cut or bruised; lamellae densely crowded, narrow, adnate, becoming decurrent, whitish to pale buff (usually "cartridge buff"); stipe 4-8 cm. long, 5-10 mm. thick at apex, enlarged downward, densely cespitose but not connate, stuffed then hollow, whitish at first from a silky covering similar to that of the pileus, pallid to dull grayish and subglabrescent in age.

Spores 4-5 x 3-3.5 μ, broadly ellipsoid, minutely echinulate under oil, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama of narrow interwoven nonamyloid hyphae; pileus trama homogeneous, not amyloid, cuticle of interwoven hyphae 5-8 μ in dia., clamp connections present.

Cespitose on soil in an oak-aspen forest, Milford, Mich., Aug. 10, 1937.

Observations: As pointed out under *C. cerrusata* var. *pithyophila* this species is distinct and Kauffman's disposition of it must be disregarded. In all of its macroscopic characters except the cespitose habit, however, it does closely resemble the species of the *cerussata* group. In all except its spore characters, it appears to be very similar to *Clitocybe connata* of Lange (1935) and Bresadola (1928), but not Konrad & Maublanc (1924-33). The latter described the spores of *C. connata* as granulose, indicating that they are very likely minutely roughened. There appears to be a strong possibility that these investigator's had Murrill's species instead. I have collected the *Clitocybe connata* of Bresadola and Lange in Michigan (Ann Arbor, Oct. 5, 1933; 33-1098: Pinckney, Oct. 15, 1936; 6064). If differs in having slightly larger, smooth spores, and apparently discoloring more when dried. Singer (1942) in his report on a study of the type of *C. subconnexa* placed the species in the *inversa*-group. In the Friesian system it would likely fall in the section *Difformes* because of its cespitose habit and would key out beside *C. connata* as far as macroscopic characters are concerned. A careful study of Clitocybe is needed to determine the number of rough-spored species. When such a study has been made it will very likely be found that several phylogenetic series exist which are characterized by minutely echinulate spores.

CLITOCYBE SUBINVERSA Murrill, Mycologia 5: 212. 1913.

Pileus 1.5-3.5 cm. broad, convex when young, the margin curved in at first, the disc soon depressed and the margin finally spreading or uplifted, surface glabrous, polished, translucent striate on the margin, subviscid to the touch when wet, soon merely moist, pellicle not separable, color "cinnamon-buff" (buff) in and around the depression, "pinkish buff" or more yellowish toward the margin; flesh very thin and pliant, concolorous with the pileus, unchanging, odor none, taste mild; lamellae close to subdistant, 30-35 decurrent on stipe, 2-3 tiers of lamellulae, narrow to moderately broad (3 mm. $\pm$), tapered either way, decurrent, "cartridge buff" (pale whitish yellow), only slightly darker at maturity, edges even; stipe short, 3-4 (5) cm. long, 2.5-4 mm. thick at the apex, enlarged slightly below, hollow, sparsely white-fibrillose when young but soon glabrous and polished, concolorous with pileus or a bit darker, especially toward the base, base with white cottony mycelium holding much debris.

Spores globose to subglobose, 3-3.5 μ, hyaline, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama interwoven, the hyphae narrow, subhymenium slightly gelatinous in KOH but not so in water mounts of fresh material, not amyloid; pileus trama homogeneous, not amyloid, a few hyphae projecting 10-15 μ as pilocystidia.

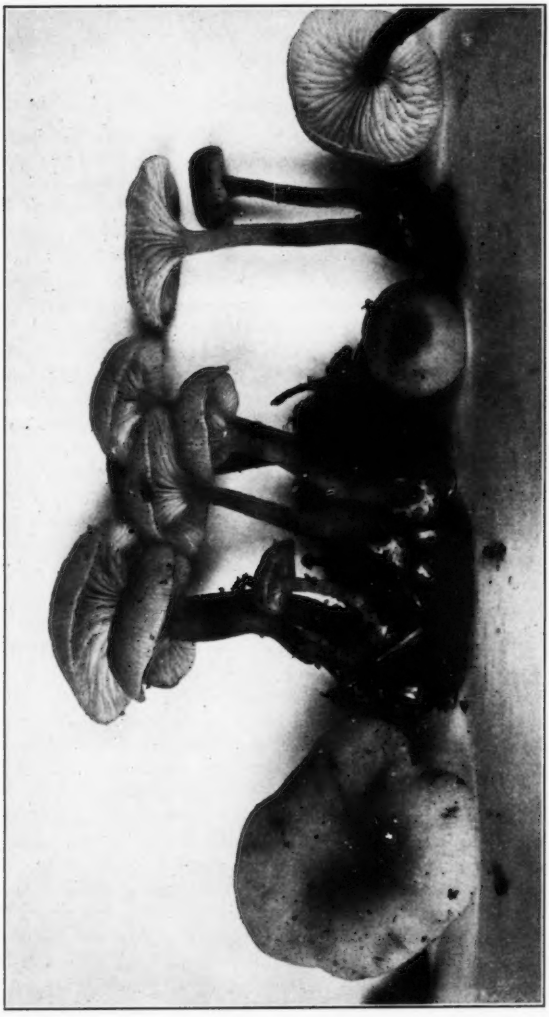

PLATE 2. *Clitocybe subinversa* Murrill

Gregarious under cedar, Ennis Creek, Mt. Angeles, Olympic Mountains, Wash., Oct. 7, 1941 (17,618).

Observations: This species is very close to *C. brumalis* sensu Lange by virtue of its stature and small spores, but apparently is readily distinguished by its color, particularly the cream colored gills and yellowish pileus. The color of the gills and globose spores distinguish it readily from *C. diatreta*. From *C. brunnescens* Murr. it differs in its yellowish gills which do not become fuliginous, and in having no resemblance in color to *C. cyathiformis*. If the published spore size of *C. brunnescens* is correct, that species is more than likely another synonym of *C. ditopoda*. Singer (1942) has already placed *C. murinifolia* Murr. in synonymy with *C. ditopoda*. It also appears likely that *C. brumalis* sensu Lange is nothing more than a slight color variation of the latter. I have colleced what appears to be *C. ditopoda* on the west coast and find the spores vary from broadly ellipsoid to subglobose. They are likely to appear globose under the microscope because they are so small that they do not settle readily to the bottom of the mount and hence one is likely to obtain an end instead of a side view of them.

CLITOCYBE VARIABILIS Murrill, Mycologia 5: 213. 1913.

Pileus 2-5.5 cm. broad, broadly convex to turbinate, some obtusely conic, the margin inrolled, expanding to plane with a slight umbo and finally becoming plane or with a slightly depressed disc, the margin wavy or sometimes elevated in age (but cap never truly vase-shaped), sometimes ribbed along the margin, often remaining somewhat umbonate, surface pure shining white at first but gradually becoming dingy and some drying with a faint cinereous tinge, sometimes sordid cream-color on the disc in age, glabrous but appearing felty-fibrillose under a lens and the margin slightly tomentose, sometimes the surface slightly areolate or with minute spotlike scales, occasionally with watery spots near the margin; flesh thick and firm in the disc, in old caps soft and fragile, white, taste mild, odor none or very faintly fragrant, unchanging when cut or bruised; lamellae moderately close to distant, 30-35 reach the stipe, 3 tiers of lamellulae, narrow, broadly adnate but becoming long-decurrent, tapering both ways, few to many forked, pure white or tinged cream or buff in age, edges even; stipe (2) 4-6 cm. long, 5-7 (10) mm. thick, solid, equal, fleshy and firm, white or whitish throughout or tinged incarnate-brownish, at first umpolished from a thin white fibrillose covering, apex pruinose, base without rhizomorphs but more or less white-mycelioid.

Spores broadly ellipsoid, 6.5-8.5 x 4-4.5 (5) μ, not amyloid, smooth; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama not amyloid, of interwoven narrow (4-7 μ) hyphae; pileus trama loosely interwoven, not amyloid, hyphae 4-8 μ in dia., clamp connections abundant.

Gregarious under conifers, Blue River, Ore., Oct. 15, 1937 (7832); under spruce near Lick Creek Summit, Idaho National Forest, Idaho, Aug. 2, 1941 (15,959) and under alder and Douglas fir, Lake Mills, Olympic Mountains, Wash., Sept. 25, 1941 (17,261).

PLATE 2. *Clitocybe subinversa* Murrill

PLATE 3. *Tricholoma cingulatum* (Fr.) Jacobsh.

PLATE 3. *Tricholoma cingulatum* (Fr.) Jacobsh.

Observations: This species has much the appearance of *Leucopaxillus albissimus* before its colors become sordid, but is at once distinguished by the smooth nonamyloid spores. It is apparently widely distributed throughout the mountains of western United States. The most closely related European species appears to be *Clitocybe ericetorum*. Singer (1942) in his study of the type of *C. variabilis* gave the spores as 5-8 x 3-5 μ, and commented on their variability. Bresadola gives the spores of *C. ericetorum* as 4-5 x 2.5-3 μ, and Lange 5.5 x 4.5 μ. In spite of these variations it appears that the American collections have consistently longer spores than those of *C. ericetorum*. I was at first inclined to place my collection in *C. washingtonensis* Murrill, but a study of that type revealed that its spores were distinctly smaller 4.5-5 x 3-3.5 μ. The latter species also has a superficial resemblance to some Leucopaxilli in the dried condition, but it does not appear to resemble *C. ericetotrum* in any except spore characters. It may be identical with *C. phyllophila* sensu Lange (1935).

PHOLIOTA TERRESTRIS Overholts, North Amer. Flora 10:268. 1924.

Pileus (1) 2-8 (10) cm. broad, when young obtusely conic to convex, soon obtusely umbonate, at maturity expanded and with a slight umbo, sometimes nearly plane, usually covered with numerous fibrillose scales or merely fibrillose-streaked toward the margin, a gelatinous layer present beneath the scales and the latter consequently becoming rather readily weathered away in wet weather, scales or fibrils "wood brown" (dark avellaneous) along the margin, near "Verona brown" on disc, when young evenly "warm sepia" over all because of the dense scaly covering, sometimes "Prout's brown" to "cinnamon brown" when freshly matured (colors variable between cinnamon brown and dark avellaneous), margin usually fibrillose-appendiculate; flesh rather thick (4 mm. or more), watery buff to brown, pliant and subcartilaginous, odor and taste perfectly mild; lamellae narrow, crowded, adnate, pallid, becoming pale avellaneous and finally sometimes faintly tinged "Isabella color" (sordid olive-yellow), pale cinnamon when dried, edges slightly uneven; stipe 3-8 cm. long, (2) 5-10 mm. thick, equal or narrowed below, solid but soon hollowed, flesh grayish but with a strong tendency to stain yellow to brownish at the base or around worm holes, occasionally staining where bruised or handled, surface covered up to a superior annular zone or ring by dark avellaneous recurved scales, scales larger and more numerous upward, sometimes the sheath merely becoming broken into zones or patches instead of scales, apical region fibrillose-pruinose, grayish or tinged yellowish.

Spores 5-6.5 x 3.5-4.5 μ, subellipsoid, smooth, with a very small apical germ pore (viewed with an oil immersion lens), dull "Verona brown" in deposits; basidia four-spored; cheilocystidia abundant, subfusoid to subcylindric, the apex usually subcapitate, 24-28 x 5-8 μ; pleurocystidia scattered and relatively inconspicuous in KOH, hyaline except for an amorphous highly refractive globular or irregular content, narrow to broadly fusoid with very acute apices, sometimes homogeneous and hyaline, dark brown basidia-like bodies present but rare; gill trama with a floccose regular central strand and a broad subgelatinous subhymenium; pileus trama with a more or less pronounced

gelatinous layer of brown-walled hyphae forming the cuticle (beneath the scales).

Very densely cespitose to gregarious along roadsides and in meadows, Lake Tahkenitch, Ore. Nov. 23, 1935 (3599); Crescent City Calif., Oct. 29, 1937 (8194); Heart O'Hills, Mt. Angeles, Olympic Mts. Wash., Sept. 18, 1941 (16,958); Hurricane Ridge, Olympic National Park, Sept. 20, 1941 (17,035).

Observations: This species has been observed in great quantity along country roads throughout Washington, Oregon and California. The size of the carpophores is variable as well as the size of the clusters in which they grow. One sometimes finds large clusters of small fruiting bodies, or small clusters of large ones. Coll. 8194 contained large clusters of large carpophores. The viscidity of the pileus is easily overlooked in dry weather or on young caps, but the gelatinous layer can be readily demonstrated from either fresh or dried specimens. This species appears to bear the same relationship to *Pholiota terrigena* that *Pholiota squarrosoides* bears to *P. squarrosa*. The small spores, viscid pileus, inconspicuous pleurocystidia, the tendency for the stipe to stain yellowish, and the brown scales over the stipe and pileus readily distinguish it from closely related species. My first impression of the habitat was that it was lignicolous and growing from buried wood, but repeated attempts to demonstrate this failed. Since the species was originally described from dried specimens, it appeared desirable to publish a detailed study of fresh material.

Tricholoma portentosum var. **avellaneifolium** (Murrill), comb. nov.

Tricholoma avellaneifolium Murrill, Mycologia **5**:223. 1913.

Pileus 4-10 (12) cm. broad, obtuse to subconic young, become obtusely umbonate, convex or plane, margin incurved at first and frequently wavy to irregular and lobed in age, glabrous, viscid, polished, usually radially rugulose and occasionally slightly streaked from agglutinated fibrils, usually "benzo brown" on the disc and "drab" to "ecru drab" along the margin (dark brownish gray on disc to pale gray toward the margin—some pallid over all or with only a tinge of "ecru drab" on the disc, never yellowish in any part); flesh thick but tapered and thin toward the margin, soft and rather fragile, pallid or pale violaceous gray, odor very strong and subfarinaceous (similar to that of *Mycena cinerella*), taste very strongly rancid-farinaceous, no color changes on cut or bruised portions; lamellae close, broad and ventricose, depressed-adnate to shallowly adnexed, white to pallid ("tilleul buff") or tinged faintly with violaceous gray, edges uneven to eroded, not changing color when bruised stipe 6-12 (24) cm. long, 1-2 (3) cm. thick at the apex, equal or nearly so, soon hollow, pallid to violaceous gray within, surface white or faintly tinged gray, more or less appressed fibrillose up to the silky apex.

Spores 4.5-6 x 4-5 μ, subglobose, smooth, not amyloid; basidia four-spored, (28) 32-36 x 5-7 μ; pleurocystidia none; cheilocystidia scattered, saccate, thin walled and readily collapsing, 24-32 x 7-11 μ, gill trama of subparallel to somewhat interwoven hyphae, not amyloid; pileus trama homogeneous beneath a gelatinous pellicle, not amyloid.

Scattered to subcespitose under mixed conifers (Douglas fir, hemlock and pine) Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941 (17,728); Oct. 11 (17,804); and Oct. 15, (17,917).

Observations: The fungus was very abundant and its fruiting was followed from the time the first few scattered specimens appeared until the forest was littered with old decaying carpophores produced at the peak of the fruiting cycle. None was found with yellowish stains on any part. I have collected abundant material of *T. portenosum* var. *typicum* in which the gills and stipe assume yellowish tints in age. *T. portentosum* var. *avellaneifolium* differs from this material in the almost complete lack of fibrillose streaks on the pileus, lack of yellow tints, in having a longer stipe, a pronounced odor and taste, and possibly by the slighly more globose spores. Murrill, however, did not mention the odor or taste in either of his descriptions. Since the lack of yellowish tints appears to be the more significant character, it is the one by which the variety is best differentiated.

TRICHOLOMA CINGULATUM (Fries) Jacobsh., Verh. Bot. Ver. Prov. Brandenb. 33: 55. 1890.

Armillaria cingulata (Fr.) Quel., Champ Jura et Vosges: 74. 1872.

Pileus 2-3.5 cm. broad, obtuse or soon obtusely campanulate, becoming expanded or umbonate with a spreading margin, margin incurved and cottony at first, in age frequently split radially, surface dry, appressed fibrillose, the fibrils sometimes becoming arranged in patches forming appressed scales, when young "drab gray" (dull gray) over all or "pallid mouse gray" (gray with a bluish cast) along the margin, changing in age to more or less "wood brown" (dark avellaneous); flesh thick under the disc but abruptly thinner away from the stipe, moderately fragile, watery drab gray when moist, pallid when faded, odor and taste farinaceous; lamellae close (71 ± reach the stipe), 1-2 tiers of lamellulae, squarely adnate at first but developing a slight tooth in age, narrow (3 mm. ±), equal, pallid grayish but becoming nearly white, in age tending to stain greenish yellow, edges even; stipe 4-6 cm. long, 3-6 mm. thick at apex, slightly enlarged below, solid, pallid to pale gray within, surface whitish or near the apex a pale bluish gray, annulate from the submembranous to fibrillose remains of a copious veil, with appressed white fibrils or zones for some distance below the ring, silky at the apex and more or less glabrous at the base.

Spores 4-5 x 2.5-3 μ, ellipsoid, hyaline, smooth, not amyloid; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill-trama of subparallel nonamyloid hyphae; pileus trama not amyloid, homogeneous, the hyphae on the surface somewhat tangled and with free ends aggregated into fasciles which form the scales.

Gregarious under alder and conifers, Lake Mills, Olympic Mountains, Washington, Sept. 20, 1941, Helen V. Smith (A. H. Smith no. 17,021).

Observations: Lange (1935) has given a very fine illustration of this rare fungus. That of Bresadola (1926), as *Armillaria cingulata,* was apparently made from rather short-stiped carpophores and the color of the pileus appears

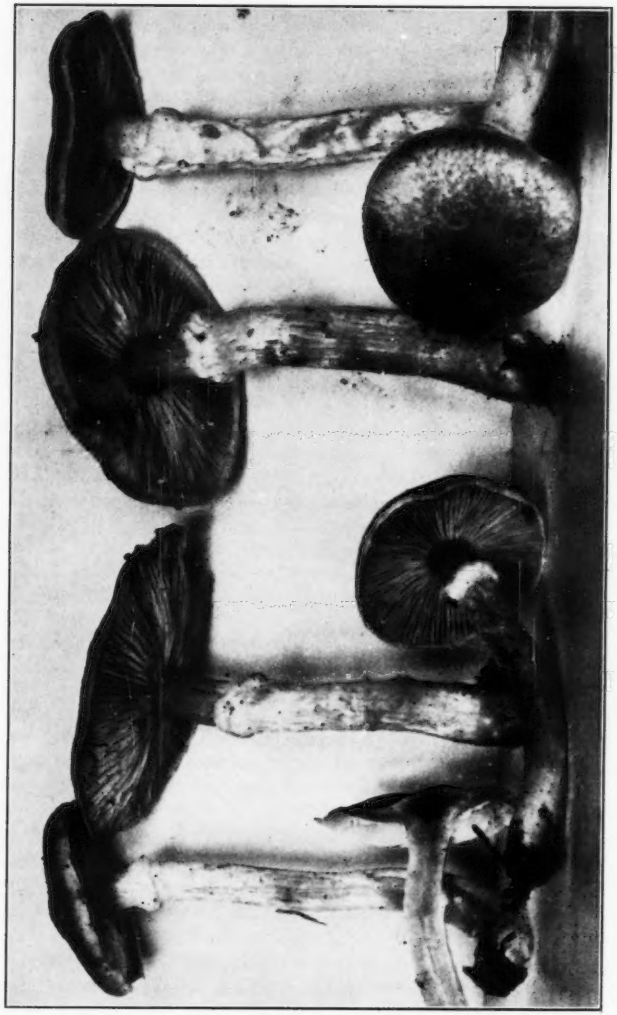

PLATE 4. *Tricholoma pardinum* Quélet

to have suffered somewhat in the process of reproduction. Although no willow was noted in the immediate vicinity of the fruiting bodies from Lake Mills, at least one species of Salix was growing in that area.

In view of the similarity of this species to the others in the stirps Myomyces of Tricholoma, it should unquestionably be arranged there in any natural classification. The annulus is not truly membranous but rather a compact cottony roll of fibrils, and thus differs only in the degree of its development from those of the other species of the stirps which possess more or less well developed fibrillose veils. The slight yellowish stains which develop on the gills of the Olympic collections indicate a very close relationship to *T. argyraceum*. Lange noted that the gills became yellowish in age. Métrod (1939) uses the name *Tricholoma ramentaceum* for this species.

TRICHOLOMA NIGROMARGINATUM Bresadola, Studi Trentini anno VII, ser. II, fasc. 1:52, fig. 1.

Pileus 4-8 cm. broad, obtuse with a somewhat incurved margin at first, becoming plane or slightly umbonate, margin spreading in age, surface dry, disc dark gray from a dense fibrillose coating which breaks up into minute scales, covered with small fibrillose scales toward the margin, dominant color gray (pale flesh visible between the scales near the margin); flesh pallid, unchanging when bruised or cut, odor none, taste slightly farinoceous; lamellae subdistant, broad, broadly adnexed and becoming more or less sinuate, whitish, edges soon blackening; stipe 3-8 cm. long, 1-1.5 mm. thick, stuffed, equal or the base thickened slightly, surface pallid, sparsely fibrillose scaly, the scales concolorous with those of the pileus.

Spores 5-6 x 3.5-4.5 μ, broadly ellipsoid, smooth, not amyloid; basidia four-spored; pleurocystidia and cheilocystidia not differentiated; gill trama regular but somewhat interwoven, not amyloid; pileus trama not amyloid, homogeneous, surface layer of radially arranged more or less fasciculate brownish hyphae with abundant clamp connections.

Under mixed conifers and madrona, Siskiyou Fork, Smith River, California, Nov. 30, 1937, Mr. and Mrs. H. E. Parks and A. H. Smith (9271).

Observations: The scales of the stipe were much less pronounced than is indicated in Bresadola's illustration. Aside from this one minor discrepancy, the above collection appears identical with Bresadola's species. The color of the scales on the pileus is not as dark as that usually indicated for *T. atrosquamosum*, and much paler than in *T. atroviolaceum*. In addition, the spores of the latter are larger. Konrad & Maublanc (1924-33) consider *T. nigromarginatum* a synonym of *T. atrosquamosum* (Chev.) Sacc., but illustrate cheilocysdidia for the latter. Since Bresadola did not describe the sterile cells as present on the gill edges of his species, and since there were none on the carpophores of the California collection, the synonymy given by Konrad & Maublanc is not accepted. In view of the difficulties of working with this group of species, an examination of the type of *T. nigromarginatum* is necessary in order to confirm my identification. Actually, the name *nigromarginatum*, although appropriate, is not distinctive. A number of fungi in this group

PLATE 4. *Tricholoma pardinum* Quélet

possess the same character. Singer now limits the genus Tricholoma to species lacking clamp connections on the carpophores. If this limitation were accepted *T. nigromarginatum* would probably be placed in the genus Tricholomopsis. Here, however, it does not seem to find natural relationships because of the lack of cheilocystidia, pleurocystidia and pilocystidia. For the present I prefer to retain the species in Tricholoma. The fibrillose dark to pale gray or bluish to blackish species form a very complex evolutionary series and although my notes are extensive, it is more than apparent that much more field work needs to be carried out before the North American species can be properly classified.

TRICHOLOMA RHINARIA (Berk. & Curt.) Saccardo, Syll. Fung. 5: 100. 1887.

Pileus 4-5 cm. broad, obtuse to plane or the margin repand, surface dry, margin "mustard yellow," disc "old gold" or more brownish (pale bright yellow on margin, disc darker yellow to yellowish brown), minutely lacerate scaly from the margin to near the disc, disc innately fibrillose; flesh white, thick, firm, odor farinaceous, taste slightly so, no color changes when cut or bruised; lamellae crowded, narrow, frequently forked, adnexed, white, edges even; stipe 6-8 cm. long, 1.5-2 cm. thick, equal or sharply tapered downward, stuffed by a fibrous pith, becoming hollow, whitish but at first covered by minute brownish gray squamules, more or less glabrescent and appressed fibrillose in age.

Spores 6-7 x 4-4.5 μ, broadly ellipsoid with an oblique apiculus, smooth, not amyloid; basidia four-spored; pleurocystidia none; cheilocystidia 30-42 x 7-12 μ scattered, thin-walled, hyaline; gill trama subregular, not amyloid; pileus trama homogeneous. not amyloid.

Singly under oak, Silver Lake, Dexter, Mich. Oct. 2, 1936 (4999).

Observations: In appearance this species resembles *Tricholoma sejunctum,* (Fr.) Quél. but the dry minutely scaly pileus and squamulose stipe distinguish it. In all characters except color it is similar to the various species related to *T. terreum,* (Fr.) Quél. It lacks the color-change of *T. luteomaculosum,* Smith, and has merely a farinaceous taste as well as larger spores. *T. subluteum* Pk. apparently differs in having globose spores and is said to be a larger plant with a yellow stipe. *T. odoriferum* Murr. is said to have spores 8-9 x 5.5-6.5 μ as well as a strong odor, and is apparently very close to *T. sulphureum.* I have not examined type material of *Agaricus rhinarius,* but from the description it appears that the colors, squamulose pileus, forked gills and furaceous stipe are sufficient to identify the species. Murrill (1914) placed it among the viscid species in his treatment of Melanoleuca, but it is difficult to understand why. Berkeley & Curtis (1859) p. 284 (not p. 2), stated that it is allied to *Agaricus scalpturatus,* a dry fungus. I can think of no better comparison.

TRICHOLOMA PARDINUM Quélet, Fungi Jura et Vosges 2: 339. 1873.

Pileus 4-15 cm. broad, convex to hemispheric when young, broadly convex to plane in age or with a low broad umbo which tends to disappear and a decurved and inrolled margin, surface dry and covered by a "mouse gray" to

"light drab" (very pale to fairly dark gray) fibrillose covering which soon becomes broken up or torn into numerous rows of appressed or slightly recurved fibrillose scales, scales smaller and paler near the margin, usually darker gray on the disc and paler gray toward the whitish fibrillose margin; flesh thick (15 mm. ±) at the stipe, white or tinged pallid grayish, rather firm and hard, odor none or faintly farinaceous, taste distinctly farinaceous, no color change when bruised; lamellae sinuate to deeply and broadly adnexed, moderately broad (1 cm. ±), not ventricose, tapering to the margin in the expanded caps, close (100-116 reach the stipe), 1-2 tiers of lamellulae, creamy to white or merely pallid, at times flushed pale pinkish or occasionally discoloring slightly to grayish when bruised, edges even at first but eroded in age; stipe 8-15 cm. long, 1-2.5 cm. thick at the apex, solid, clavate at first, nearly equal in age, white within, surface white or whitish, occasionally tinged ashy or stained yellowish to rusty at the base, glabrous or appressed fibrillose and glabrescent, apex slightly furfuraceous to pruinose, no veil present in button stages.

Spores rather variable in length, 6-8 x 5-6 μ (no. 3290), 7-9 x 5-6 μ (17,541), 8-10 x 5-6 μ (8090), ellipsoid to subovooid, not amyloid, smooth; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama more or less parallel, not amyloid; pileus trama homogeneous beneath the radially arranged surface fibrils.

Gregarious to scattered under conifers, common, Lake Crescent, Wash., Oct. 22, 1935 (3290); under ponderosa pine, McKenzie Pass, Ore., Oct. 21, 1937 (8090); Deschutes National Forest Ore., Oct. 23, 1937 (8123); scattered under redwood, Crescent City, Calif., Nov. 3, 1937 (8355;); singly under ponderosa pine, Kerby, Ore., Nov. 26, 1937 (9119); under mixed conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941 (17,480) and Oct. 2, (17,541); Sisters, Ore. under ponderosa pine, Oct. 31, 1941 (18,220). The description was drawn from collection 17,541.

Observations: This is the *Tricholoma tigrinum* of many European authors, but that name has been the source of considerable confusion. Consequently it appears best to use the name employed by the French mycologists. *Tricholoma huronense* Smith is closely related to this species but differs in the presence of reddish exuded drops of fluid on the gills and stipe, in the cinerescent fibrillose scales of the stipe, consistently narrow gills in even the largest pilei, and by the presence of cheilocystidia. *T. huronense* also appears to be limited to hardwood habitats, but this distinction may not prove constant. *T. venenatum* Atk. is also close to *T. pardinum* but readily distinct by the paler colors which become avellaneous in age, by the changing gills and by the presence of scattered saccate cheilocystidia. Its spores also average shorter and narrower than in *T. pardinum*, although this difference is slight.

Melanoleuca secedifolia Murrill as described in the North American Flora 10: 29 is apparently identical with *P. pardinum*, but the original descripton based on Morton Peck's collection no. 34 clearly applies to a different species. Singer (1942) studied a collection by Morton Peck which he thought was the type. It was characterized by abundant cheilocystidia. The material I studied was labeled as authentic by Murrill, but was not the type. It did not possess

PLATE 5. *Flammula punctifolia* (Pk.) Smith

cheilocystidia. According to accepted nomenclatorial procedure, the type established the species, and Murrill's account in the North American Flora must therefore be regarded as erroneous.

AMANITA ASPER (Fries.) Quélet, *sensu* Ricken, Lange, Rea, and Konrad & Maublanc.

Pileus 4-8 cm. broad, obtuse to convex when young, plane or with a slight umbo in age, margin even or very short striate, viscid, surface covered at first by "chamois" (dull yellow) pulverulent to floccose patches of universal veil tissue that become aggregated into deciduous warts and become sordid yellow to grayish or brownish in age, color beneath the scales "raw umber" to "bister" or "Dresden brown" (dark sordid brown) on the disc, "ochre-yellow" or more sordid grayish yellow toward the margin or at times "buckthorn brown"; flesh white or yellowish under the cuticle, moderately fragile, odor none, unchanging when cut; lamellae close, broad, approximate to the stipe or attached by a tooth, two tiers of lamellulae, white when young but soon assuming a yellowish cast near the cap margin or over all, edges slightly crenulate; stipe (4) 8-12 cm. long, 10-15 mm. thick at the apex, thickened downward to a more or less clavate bulb which is either pointed or flattened below, stuffed solid, striate and pale yellow to brownish yellow above the superior annulus, slightly pruinose, furnished with yellow furfuraceous zones below the annulus, glabrescent in age and then more or less silky, basal portion with rings of veil tissue left by the very friable universal veil, these remnants usually grayish on the surface and yellow underneath, base of bulb and the interior slowly staining reddish brown when cut or bruised; annulus double, pale yellow above, yellowish or grayish fibrillose to subscaly beneath.

Spores 7-10 x 5.5-7 μ, broadly ellipsoid, smooth, amyloid; basidia four-spored; pleurocystidia not differentiated; cheilocystidia scattered to abundant, subcapitate, 38-48 x 9-15 μ, thin walled and readily collapsing; gill trama of hyphae divergent from a central strand, the cells short and broad, not amyloid; pileus trama floccose beneath a thin gelatinous pellicle, not amyloid.

Scattered under conifers, Washington, Oregon and California. Kauffman collected it at Lake Quinault, Washington, and I have made the following collections: Under pine, Siltcoos Outlet Forest Camp, Siltcoos National Forest, Ore., Nov. 14, 1935 (3481); under redwood, Trinidad, Calif. Nov. 28, 1935 (3640), Dec. 6 (3835); Crescent City, Calif., Nov. 4, 1937 (8410); Fort Dick, Calif., Nov., 1937 (8538); Trinidad, Nov. 12 (8686), Dec. 6, 1937 (9468); Timberline Camp, Mt. Baker, Wash., Aug. 24, 1941, under mixed fir and hemlock (16,342); Sandy Creek Trail, Mt. Baker, Aug. 30 (Mains and Smith no. 16,480); Noisy Creek, Baker Lake, Wash., Sept. 5, 1941 (16,638).

Observations: This species is intermediate between *A. flavoconia* Atk., *A. flavorubescens* Atk. and *A. rubescens* (Fr.) Quél. by virtue of its friable universal veil and tendency to develop yellowish colors at least in some parts. The degree of yellow present varies greatly. The collection from which the description was made, no. 8538, had pronounced yellowish tints. In some from Mt. Baker, Washington, however, they were almost lacking. *A. flavoconia* and

PLATE 6. *Pholiota terrestris* Overholts

A. flavorubescens lack the dark color of *A. asper*, and *A. rubescens* besides showing pronounced reddish discolorations seldom shows any tendency to develop yellow colors in young or freshly matured carpophores. Murrill considered *A. aspera* a synonym of *A. rubescens* but did not report either from the western states. I have found typical *A. rubescens* in California (no. 8792). Hotson (1936) did not report either from Washington. An examination of the descriptions of Murrill's new species from our west coast failed to reveal the presence of *A. aspera* under a different name. Konrad & Maublanc (1924-30) point out that this fungus is not the *A. asper* of the older authors including Fries, but is the species according to the concept of Quélet, and many recent investigators. Since the synonymy of the species of Amanita is very involved, it appears best for the purposes of this report to publish my data under a name that has been used widely. Kauffman had tentatively regarded it as a new species in 1925. This opinion, however, was made at the time he studied his collection in the field and he obviously had not made a critical study of the literature at that time.

Flammula punctifolius (Peck) comb. nov.

Cortinarius punctifolius Peck, Bull. Torr. Club, **30**:96. 1903.
Flammula subviridis Murrill, in House, Bull. N. Y. State Mus. **179**:33. 1915.

Pileus 3-7.5 (10) cm broad, obtuse with an inrolled margin, becoming roughly umbonate or subplane, surface moist but soon dry and with a changeable sheen, the colors extremely variable, green, blue and yellow mixed in various proportions, sometimes predominantly greenish blue, sometimes olivaceous yellow or subalutaceous (near "honey yellow" on the disc and "Isabella color" toward the margin), in age appearing somewhat fibrillose or becoming areolate scaly around the disc, margin at first somewhat pubescent or at least unpolished; flesh thick but watery, "citron green" to "ecru olive" and fading to "olive-ocher" or "deep colonial buff," odor not distinctive, taste very bitter; lamellae "yellowish olive" (green) when young, becoming "Isabella color" (sordid yellowish) or sordid rusty from the spores, the edges often stained pale yellowish tawny or ferruginous, depressed adnate to sinuate, close, 57-62 reach the stipe, 3 tiers of lamellulae, broad (6-8 mm.) edges slightly eroded; stipe (3) 5-12 cm. long, 6-14 mm. thick, equal or nearly so, stuffed but becoming hollow, fibrous, "aniline yellow" to "olive-ocher" within and soon fading to "deep colonial buff" or more solid in the base, surface evenly finely granular-pruinose and concolorous with the pileus (various mixtures of bluish green or yellowish green).

Spores broadly ellipsoid to ovate pointed, dark rusty brown in KOH, roughened with minute but distinct tubercles, 5-7 x 4-5 μ; basidia four-spored; pleurocystidia not seen; cheilocystidia rare to abundant, 24-36 x 4-7 μ, subfusoid with more or less slightly enlarged and rounded apices; gill trama parallel and homogeneous; pileus trama homogeneous.

Common but never occurring in quantity. One usually finds one or two fruiting bodies during the course of a day's collecting. The description was drawn from the most representative collection made in 1941 (Smith no.

17,140). It was made in the vicinity of Olympic Hot Springs, Olympic National Park, Wash.

Observations: This species can be found either on old stumps and logs or on very rich humus in the vicinity of very decayed wood. The whitish pulverulence noted by Kauffman (1926) is very evanescent during wet seasons. Kauffman (1932) excluded this species from Cortinarius stating that it was a better Flammula. However, he did not include it in his key to the North American species of Flammula. This key was written after he submitted his Cortinarius manuscript for publication. The microscopic characters of the type of *C. punctifolius* Pk. have been found to be exactly as given in the above description and no signficant differences are evident in the descriptions of the macroscopic characters. Hence *F. subviridis* Murrill is considered a synonym of Peck's species.

HEBELOMA STROPHOSUM (Fries) Sacc., Syll. Fung. 5: 808. 1887.

Pileus 3-7 cm. broad, obtuse and with an inrolled margin when young, becoming broadly umbonate to nearly plane, finally plane or with an elevated and often wavy margin in age, surface viscid or glutinous when fresh, marginal area usually decorated with one or several rows of floccose-fibrillose patches of veil tissue, or streaked with fibrils, somewhat glabrescent, the veil remnants buff colored, surface "cinnamon-buff" to "ochraceous tawny" on the disc, paler toward the margin (yellowish brown on disc, buff or pale buff along the margin), sometimes more or less clay color or even darker on the center; flesh thick in the disc, thinner near the margin (6 mm. ±), pliant, watery avellaneous, odor when crushed pungent to subraphanoid, taste slightly raphanoid, lamellae close, 52-65 reach the stipe, 3 tiers of lamellulae more or less, bluntly or depressed adnate, at times with a slight tooth, narrow to moderately broad and becoming slightly ventricose, 5-6 mm. in ventricose portion, "tilleul buff" (pallid) young, becoming "avellaneous" and finally "vinaceous buff" to "sayal brown" or a darker more rusty brown, sometimes stained darker along the edges, edges even or becoming eroded; stipe 5-8 cm. long 8-18 mm. thick, equal or narrowed at the base, solid but becoming hollow, pallid in the cortex but soon darker brownish in the base, surface over lower two thirds covered by the ragged remains of the cinnamon buff universal veil, pallid and silky above, the copius whitish cortina leaving an apical fibrillose ring, darkening from the base upward in age.

Spores 8-10 x 4.5-6 μ, ovoid to subellipsoid, very pale in KOH, smooth or nearly so; basidia four-spored; pleurocystidia not seen; cheilocystia abundant, 46-65 x 8-12 μ, fusoid ventricose with a long nearly cylindric often somewhat flexuous neck; gill trama homogeneous, of subparallel hyphae; pileus trama homogeneous beneath a gelatinous pellicle or the region directly beneath the pellicle with slightly enlarged hyphae.

Gregarious to subcespitose, under conifers, Heart O' Hills, Mt. Angeles, Olympic Mts., Wash., June 19, 1939 (14,443 and 14,451); same locality, Sept. 21 and 22, 1941 (17,096 and 17,184).

Observations: Lange's (1938) illustration is excellent for small specimens. Robust carpophores present an even more ragged appearance than he has shown, but the pale flesh-tint in the gills is very constant. This species apparently is fairly common on the slopes of Mt. Angeles, but I have not collected it in other localities either in the Olympics or in the west coast area as a whole.

OMPHALIA KALCHBRENNERI Bresadola, Fung. Trid. 1: 32, pl. 35, fig. 1. 1883.

Pileus 3-5 cm. broad, disc deeply depressed, the marginal area arched and more or less parallel with the stipe at the edge, expanded and with a somewhat spreading margin at maturity, glabrous, hygraphanous, opaque to faintly translucent striate when moist, evenly colored pale avellaneous tinged with yellow (between "pinkish buff" and "avellaneous"), pallid when faded; flesh thin but nearly equal (1.5-2 mm. near the stipe, 1 mm. near the margin) concolorous with the surface, taste mild, odor faintly but distinctly fragrant; lamellae subdistant to nearly distant, 23-27 decurrent on the stipe, 3 tiers of lamellulae, moderately broad, (5-6 mm.) tapered to either end, intervenose, "tilleul buff" or darker and slightly yellowish; stipe 5-6 cm. long, 5-6 mm. thick at the apex, equal or a bit enlarged below, hollow, with a very pliant subcartilaginous cortex, surface glabrous except for white mycelium and rhizomorphs around the base, concolorous with the pileus or a bit darker, evenly colored throughout.

Spores 7-8.5 (9) x 4-4.5 μ, ellipsoid, smooth, weakly amyloid; basidia four-spored; pleurocysidia not differentiated; cheilocystidia rare, filamentous, 3 μ $\pm$ in dia.; gill trama interwoven, the hyphae narrow, not amyloid; the subhymenium subgelatinous in KOH; pileus trama not amyloid, homogeneous, the hyphae 5-9 μ thick, surface layer subgelatinous in KOH.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941 (17,674).

Observations: The fresh pilei were not viscid, and when sectioned the cuticle did not gelatinize in water mounts, the only mounts made at the time. Consequently no emphasis has been placed upon the gelatinization observed in the material revived in KOH, even though as a rule such gelatinization is a good indication that the fresh material was viscid or at least decidedly lubricous. Singer (1942) reported filamentous cheilocystidia as present but scattered in this species. In my collection they were present but hardly projected beyond the basidia, and only a very few were seen. Singer places this species in the genus Xeromphalina. The name used here is that of the Friesian system. When the specimens were collected they were tentatively placed in the genus Clitocybe. If the genus Xeromphalina is to be based on *X. campanella (Omphalia campanella)*, it appears to be a violation of natural relationships to place such species as *O. Kalchbrenneri* in it.

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A Bibliography Pertaining to the Mite Family Trombidiidae[1]

Roger W. Williams[2]

The interest in certain representatives of the mite family Trombidiidae has increased greatly and research on those forms parasitic on man has received considerable stimulus as the significant role they play in the lives of our military personnel has become more and more apparent. In this country the common North American chigger, *Eutrombicula alfreddugesi* (Oudemans), is becoming a true natural bottleneck in our wartime program. The violent itching caused by this pest has led to the loss of many hours of sleep among our armed forces, with a consequent drop in efficiency. Secondary infections derived from scratching has accounted for hundreds of man hours idled away in hospital bunks. Livesay and Pollard (198) indicate that some cases of "Bullis Fever" among our soldiers in Texas have been associated with an infestation of *Trombicula* larvae. In the Pacific and Far Eastern theaters of war members of the family Trombidiidae are transmitting a malady, Tsutsugamushi disease (342), to our fighting forces, which is beginning to take on significance of sizeable proportions. Farner and Katsampes (348) give a very complete list of references, containing over 200 articles, pertaining to this disease.

To workers in any branch of scientific endeavor a bibliography of their particular subject is indispensable. It is hoped that the bibliography herewith offered will be of assistance to individuals undertaking research in this field.

In an effort to make this list of references as complete as possible, bibliographies given by Toomey (309) and Parkhurst (252) have been incorporated. Toomey, in his bibliography which contained better than 100 references published between 1789 and 1921, did not give the titles of the articles. When possible these have been added but in some cases it was necessary to accept the references as they stand in his paper. Parkhurst, in 1937, listed more than sixty articles published since 1921. Approximately 210 references have been supplemented. These represent additions to those cited by Toomey and Parkhurst as well as recent articles published since 1937.

The following letters, appending the majority of the references, designate the main features found in each publication.

A—Taxonomy and Descriptions
B—Life Cycle and/or Hosts
C—Treatment; Prevention; Control
D—Laboratory Techniques of Rearing, Mounting, Sectioning, Etc.
E—Miscellaneous Information

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Studies on the Seasonal Life History of Three Species of Freshwater Ostracoda*

Edward Ferguson, Jr.

The first scientific name given to an ostracod according to Alm (1916) was *Monoculus concha pedata* applied by Linnaeus in his 1758 edition of the *Systema Naturae*. The first significant work on the Ostracoda was done and published by O. F. Müller in 1785. Numerous papers and monographs concerning these animals have appeared since Müller's initial work but most of them have been devoted to problems involving fossil species and the taxonomy of recent forms with only fragmentary information on life history studies contained in a relative few.

During the course of this investigation which deals with the life histories of *Cypriodopsis vidua, Potamocypris smaragdina,* and *Physocypria pustulosa,* the author became interested in the structural changes associated with development from the nauplius to and including the adult forms (Figs. 1-34). Most of the observations concerning these were made from whole specimens preserved in alcohol. Limited seasonal occurrence and small size of many of the larval instars presented difficulties which prevented this phase of the study from being extensive.

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Materials and Methods

After several weeks of preliminary observations on numerous ponds and artificial lakes in the vicinity of St. Louis, Missouri, Round Lake, so designated by the St. Louis Park Commission, was selected and all the organisms studied were taken therefrom. This pond is about 100 feet in diameter, varies in depth from a few (4-5) inches near the edge to about 6 feet near the center, is supplied with a pipe for city water and another one for overflow near the center, and is located in Forest Park about 45 yards south of Grand Drive and 15 yards east of Wells Drive.

Collections were made at irregular intervals from April 7, 1941 to July 15, 1942. No collections were made 1) during November 1941, when the pond

* A contribution from the Zoological Laboratory of the University of Illinois.

was dry, 2) during February 1942, when the water was frozen to such a depth that collecting was practically impossible, and 3) on several occasions when the pond was drained for cleaning operations. However, it is believed that a sufficient number of samples were secured to provide a rather complete picture of the seasonal occurrence of the organisms studied. From a designated point on the east bank of the pond, over 400 collections were made with a Birge cone net from the surface, subsurface, and bottom of an area extending roughly 15 feet from the bank and 15 feet to either side of a selected spot. This single location was selected with the idea of keeping variable factors at a minimum.

The large end of the net measured approximately 12.5 inches in circumference, and consisted of a sheet-metal cylinder about four inches in length provided with a cone of coarse wire netting of about 7/16 inch mesh to prevent accumulation of coarse debris in the sample. A vial ½ inch in diameter was secured to the apex of the net by rubber bands. Vegetation varied from a luxuriant growth of algae and other water plants, almost covering the entire surface of the pond in mid-summer, to a scant quantity of green vegetation plus much decaying organic matter in the colder months of the winter.

Several methods were tried with reference to preparation of specimens for microscopic study. The most satisfactory preparations of adults consisted of dissections previously stained in 0.5% aqueous solution of acid fuchsin, acidulated slightly with HCl, essentially as advocated by Hoff (1942). The time required for proper staining of adult ostracods was found to depend on age of the animal, length of time elapsed since the last ecdysis, and whether or not the shell remained open. Older individuals required from 2½ to 3 hours for proper staining. After staining and dehydrating the specimens were placed in a moderately thin layer of balsam on a slide for dissection. Xylene and benzene were avoided because they rendered the shells too brittle for practical dissection. The best method for developmental stages entailed keeping the animals in homeopathic vials. Specimens were stained in acid fuchsin for 30 minutes to 1 hour, washed in N/50 HCl if needed, and dehydrated. Then they were poured in a Syracuse watch-glass and individually placed on a slide by means of a pipette. Loss of specimens was prevented by careful decantation. Alcohol was removed by blotting and dissections were made in Canada balsam. A number 3 insect pin, the point of which had been flattened and the end rounded, was mounted in a wooden handle and served as the most satisfactory instrument for dissection. Particular care was exercised during the separation of different organs to facilitate later microscopic examination.

Data are presented for each species as tables for days in each month during which collections were made. Three groups of individuals namely, early instars, late instars, and adults, were established for convenience in the preparation of data. "Early instars" as used here consists of three-appendage (nauplius) larvae and corresponds roughly to the first six developmental stages of ostracods as given by Claus (1872) and Schreiber (1922). "Late instars" refers to individuals in which the genital primordia and the definitive form of the appendages are present. "Adult" refers to sexually mature animals.

Though the present study was based chiefly on field specimens, numerous

cultures in various media were kept for comparative purposes. Such cultures were supplementary to the field studies and details pertaining to them will not be presented.

Previous Life History Studies of Freshwater Ostracoda

The vast majority of the published works on life histories, embryology, and metamorphosis of ostracods appeared during the latter half of the 19th and the first 2 decades of the present, century. Zenker (1854) published the first treatise which directed attention to the development of ostracods. Although this phase of his work was incidental it provided the necessary incentive for future investigation along similar lines. In 1872 Claus in his "Entwicklungsgeschichte von Cypris" discussed some of the larval stages of *Cypris ovum* and *Cypris fasciata*. He (1894) restated the principal developmental changes which take place during ostracod development from the nauplius to the sexually mature animals and took issue with Müller (1880) regarding the structure of the 3rd pair of cephalic appendages of the nauplius, maintaining that they were pediform and not modified for trituration as claimed by Müller. The first and only paper in regard to ostracod metamorphosis in America during the last century was that of Herrick and Turner (1895) concerning the 7th, 8th, and 9th instars of *Cypris herricki* Turner (=*Chlamydotheca speciosa* Dana, 1852).

Schreiber (1922) working with *Cyprinotus incongruens* Ramdohr, gave the first complete account of freshwater ostracod metamorphosis. This work was accomplished entirely on laboratory reared animals. Marshall (1903) studied the developmental changes of *Entocythere cambria* Marshall, 1903, a parasitic species. Rioja (1940) described some larval stages of *Entocythere heterodonta* Rioja, 1940, an ostracod parasitic on *Cambarus montezumae* Saussure, of Mexico. Alm (1916) published the first significant work on seasonal life histories of the freshwater ostracods in which he recorded observations on 22 species from Sweden. Though several investigators have listed the seasonal occurrence of these crustaceans and in some cases have presented quantitative data concerning them, it seems that only Hoff (1942) in the present century, has made any reference to particular stages of development of ostracods in the American fauna during certain seasons; he summarized the seasonal life history of *Cypricercus reticulatus* (Zaddach, 1844).

Morphology and Reproduction of the Ostracoda

Several investigators have published studies on the morphology of particular organ systems of ostracods. Hoff (1942) presented a comprehensive list of these workers and also a discussion of the general morphology of these organisms. In the present study, detailed statements regarding the adult morphology have been omitted since they are readily available in Hoff's monograph.

The Ostracoda are dioecious, and with the exception of *Darwinula stevensoni* (Brady and Robertson, 1870) are all oviparous. Both parthenogenetic and syngamic reproduction are common among these organisms. Some species reproduce by the parthenogenetic method only, for example, in *Cypriodopsis*

vidua no authenticated record of the occurrence of males has ever been presented. Weismann (1880) stated that in the two species, *Candona candida* and *Cypriodopsis vidua*, he observed both males and females during the spring and summer, but in late autumn found only females; however, subsequent investigations by numerous workers have revealed only females of *C. vidua*.

During a period of 15 months the writer collected and studied individuals of *C. vidua*, both in the field and in the laboratory, and found not a single male of this species. In sharp contrast, *Potamocypris smaragdina* and *Physocypria pustulosa* reproduce by the syngamic method only.

The literature does not reveal any record of the occurrence of alternate cycles of parthenogenetic and syngamic reproduction among the ostracods. While investigating the seasonal life histories of *C. vidua*, *P. smaragdina*, and *P. pustulosa*, observations on the distribution of males and females were made in an effort to determine whether or not an alternation of parthenogenetic and syngamic reproduction occured in *P. smaragdina* and *P. pustulosa*. There was generally an obvious numerical superiority of females, a problem investigated by Zenker (1850) and Wohlgemuth (1914), but at no time was there an absence of either sex of these species. Reports of some investigators for ostracods from Europe agree with these results, however, Klie (1926) mentions the genera *Eucypris*, *Heterocypris*, *Ilyodromas*, *Dolerocypris*, *Stenocypria*, *Cypriodopsis*, and *Potamocypris*, and also *Ilyocypris gibba* as being wholly parthenogenetic in Germany. Males of *I. gibba* have been observed in Algiers, Hungary, Spain, and Russia and the wholly parthenogenetic condition observed in Germany may be interpreted as local with reference to this species. Males of *Potamocypris smaragdina* have been reported by several American workers other than myself. Hoff (1942) found that "males were present in six of fifty collections selected at random. They appear to be equal in number to the females in the collections in which they occur. There seems to be no correlation of males and the season or locality in which they occur." Furtos (1933) in The Ostracoda of Ohio does not mention males with regard to this species which she described as *P. smaragdina* var. *compressa* and it could not be determined from the context of her paper why she made this omission. In the remarks for most of the other species which she studied, there was either a short description of the male or the statement, "male unknown." From the present work and that of Hoff however, it is clear that this, the only valid North American species of *Potamocypris*, reproduces syngamically despite the fact that species of this genus in Germany appear to be wholly parthenogenetic (Klie 1926). At our present state of knowledge it is apparent that ostracods reproduce either parthenogenetically or syngamically and that an alternation of these two methods does not occur.

Ostracod eggs are usually spherical, seldom ellipsoidal in shape, and of various colors. The eggs of *C. vidua* are green, those of *P. pustulosa* white, while those of *P. smaragdina* are vermilion. The gravid females of the latter species are readily distinguishable by the presence of the vermilion eggs enclosed in an animal of a greenish hue.

The ostracod egg possesses a double-wall shell impregnated with calcium;

the inside wall is united with the inner lamella. The cavity of the egg contains a large quantity of water which evidently enables it to resist long periods of drying (Woltereck 1898) and to become physiologically active and produce young when returned to the water. Woltereck (1898), Schleip (1909), and Müller-Calé (1913) investigated the course of development of the ostracod egg. Schleip's work involved a study of the embryology of *Cypris ovum* Jurine (=*Cyclocypris laevis* O. F. Müller) and *Notodromas monacha* (O. F. Müller, 1776) both of which reproduce syngamically, and also that of *Cypris reptans* Baird, a parthenogenetic species. Müller-Calé observed the development of *Cyprinotus incongruens* Ramdohr. From the results of these investigators it is apparent that the cleavage is total and unequal.

The rate of development of ostracod eggs is dependent on several factors. Wohlgemuth (1914) observed development of the eggs of *C. incongruens* in 1) an aquarium with water kept at 28 to 30 degrees C., 2) in culture dishes with water maintained at room temperature (17 to 19 degrees C.), and 3) in the natural habitat at a temperature which ranged from 9 to 11 degrees C. Wohlgemuth's data demonstrated that eggs kept at a temperature of from 28 to 30 degrees C. developed twice as fast as those at 17 to 19 degrees C., and eggs kept at 17 to 19 degrees C. developed twice as fast as those in the natural habitat at 9 to 11 degrees C.

Several workers have observed the process of copulation among the Ostracoda. Kaufmann (1892) in describing the process for *Leucocythere mirabilis* stated that the male scrambled upon the posterior region of the female and attached himself to her shell by means of claws located on the 2nd antennae. The male copulatory organ was turned at an angle of 180 degrees and inserted between the valves of the shell into the vagina. Rioja (1940) described this phenomenon for *Entocythere heterodonta* Rioja, in which it was essentially the same as that for *L. mirabilis* except that the male attached himself along the entire dorsal surface of the female shell instead of only on the posterior region. According to Klie (1926) Jensen described the process of *Candona fabaeformis* Fischer.

Copulation was observed several times in the present work for *P. smaragdina* in laboratory cultures. The male attached himself to the dorso-posterior region of the female shell and held securely thereto by means of the second antennae. The ventral concavity of the male shell was firmly appressed to the convex surface of the postero-dorsal part of the female shell and the valves of the latter were kept open by the long curved claw of the 2nd thoracic appendage which was used as a wedge.

Male ostracods are generally smaller than the females of the same species. Size alone however, cannot be relied on with reference to sexual dimorphism. In the present investigation, measurements for several hundreds of *P. smaragdina* and *P. pustulosa* revealed that the larger males exceeded the smaller females in size, in random field samples as well as in laboratory cultures. It was rare indeed that the males of either species attained the maximum size of the females.

Zenker (1850) concluded that males of ostracods were larger than the

females in his work on the genus *Cypris* which at that time was equivalent to the family Cypridae and also to the subclass Ostracoda. I observed that, where a size differential was great enough to be noticeable, the females were larger. The reproductive glands of mature ostracods are easily distinguished through the transparent or semi-transparent shell.

The 2nd antennae in the males of several species belonging to the Cypridae are 6-segmented but in the females are composed of only 5 podomeres. The maxillary palpus in females of *P. pustulosa* is a simple organ whereas it is a prehensile structure in the males of this species. Klie (1926) reports the presence of bristles on the ultimate article of the 2nd antennae of males belonging to the subfamily Candocyprinae. Shape and color of eggs have been alluded to above and doubtless there are many other criteria of sexual dimorphism in different families, subfamilies, etc. of the Ostracoda.

Seasonal Life Histories

Van Cleave (1931) states: "There are relatively few species of animals whose entire life history is known. The developmental cycles of even some of the species most commonly used for study in zoological laboratories have been but imperfectly traced or have been unstudied. The concept of specific life histories has not been given serious consideration by the present generation of scientists."

As mentioned previously, the bulk of life history studies concerning freshwater ostracods was accomplished by European investigators during the 19th century. The fragmentary information on life histories of North American ostracods stimulated the writer to contribute in this regard, to the knowledge of three American freshwater species, namely, *Cypriodopsis vidua, Potamocypris smaragdina,* and *Physocypria pustulosa.* It is the author's intention later to study additional American ostracod life histories.

Anyone who collects ostracods will be impressed by their sporadic appearance in a given habitat. It was observed in numerous cases that one or the other of the 3 species studied occurred abundantly on certain days whereas several days later the same species would be absent and then reappear in large numbers in subsequent collections. It is obvious therefore, that in order to present a reasonably complete picture of an ostracod life history, one must assemble information gathered from numerous collections taken for periods of several months and occasionally for 2 or 3 years.

In certain types of quantitative analyses of life history data, successive collections will reflect important events. For example the appearance of the 1st young on a given date will be reflected somewhat later by a concrete group of individuals which represent further development. When complete series of events of this type are available the population represented by a new brood, forms a normal distribution curve for which the development of individuals may be postulated by shifts in the size-distribution curves. Such perfect correlation of individual development as well as that of entire populations is rarely found in the Ostracoda. Sampling seems to leave conspicuous gaps in the

series for which there is no adequate explanation. One obvious possibility is that air currents and other physical factors might cause wide discrepancies in local distribution. Another explanation might be that individuals migrate and collect in more favorable habitats.

CYPRIODOPSIS VIDUA (O. F. Müller, 1776) Brady, 1867

Seasonal Occurrence—March 29, 1942, was the earliest date on which adults of this species were taken; the latest, December 20, 1941. Between April 26, 1941, and July 15, 1942, adults were present in every collection except the one for January (Table 1). No collections were made in November and February. Few specimens were observed in the first collections. They increased considerably during the second week of June, 1941, and were in great abundance on July 30, 1941, October 18-28, 1941, and also on June 27, 1942. The period of adult abundanace for *C. vidua* occurred in the June-October period for 1941 (Table 1) and considered from this standpoint this species is a summer-autumn form as observed by other authors.

TABLE 1.—*Cypriodopsis vidua*.*

Date of collection	Early Instars	Late Instars	Adult	Date of collection	Early Instars	Late Instars	Adult
1941				November			
April 7	–	–	×	December 20	–	–	×
April 10	–	–	–				
April 12	–	–	–	1942			
April 16	×	–	–	January 27	–	–	–
April 19	–	–	–	February			
April 26	–	×	×	March 29	–	–	×
May 13	–	××	×	April 2	–	–	×
June 10	–	×××	××	April 7	–	×	×
July 30	–	–	×××	April 27	×××	–	×
August 20	××	××	××	May 1	–	×	×
September 6	–	××	××	June 20	–	–	×
September 20	–	×	×	June 27	–	–	×××
October 18	–	×	×××	July 3	–	–	×
October 28	–	–	×××	July 15	–	–	×

Sharpe (1897) showed that *C. vidua* was present in Illinois from February to December with the maximum number occurring from May to October. Alm (1916) found this ostracod common in small bodies of water in Sweden from April to December and concluded it to be a summer-autumn form. Furtos (1933) referred to *C. vidua* as *C. vidua vidua* and observed it in Ohio from May to November. Hoff (1942) in Illinois observed this species in limited numbers in April and May and found specimens "reaching their greatest abundance in the algae and aquatic vegetation of permanent lakes, river back-waters, and vernal ponds which do not dry up until late in the serotinal season."

Duration of Adult Life.—The adult longevity of this species is approxi-

* In this and succeeding tables, –, indicates the absence of individuals of a particular developmental stage; ×, present in very small numbers; ××, abundant; ×××, very abundant.

mately 3½ to 6 months as shown by field observations and laboratory cultures. It seems reasonable that specimens becoming adult in October lived through the winter into April, a period of about 6 months. This relatively long life span partly explains why adults of *C. vidua* have been found throughout most of the year even during seasons when developmental stages were absent. The life of 1st-brood adults however, apparently extends only from June 10 to September 20 (1941) which is about 3½ months (103 days).

Broods Per Year.—Table 1 reveals two broods per year for *C. vidua*: 1) April to September and 2) August to April of the following year. The majority of the early instars of April 16, 1941, probably reached sexual maturity on the following July 30, as shown in Table 1. This portrays a developmental period of approximately 15 weeks (106 days). Similarly the early instars of August 20, 1941, became adult 10 weeks (70 days) later, on October 28. In the spring of 1942 however, the developmental period was shortened to about 9 weeks (62 days) and extended from April 27 to June 27 of that year.

A study of the time elapsed between the appearance of nauplii and a corresponding number of late instars, and the period of time for the latter to become adult, provides a reasonable answer to the question of relative rates of development of different larval stages. Table 1 shows that late instars were present on September 6, 1941, in the same relative numbers as the early instars of August 20, 17 days earlier. This suggests that the early instars required only 17 days for development and that the late instars needed 53 days to develop to sexual maturity. However, the presence of late and early instars in the same relative numbers on August 20, 1941, obscures the identity of the late instars of September 6, and suggests that early instars were present and not taken prior to August 20 (1941). In addition, the data for the spring broods of 1941 and 1942 (Table 1) suggests 11 and 5 days respectively, as developmental periods for early instars of this species. Data from representative weekly collections are needed to correctly establish the developmental periods involved here.

POTAMOCYPRIS SMARAGDINA (Vávra, 1891) Daday, 1900

Seasonal Occurrence.—Adults of *P. smaragdina* were taken in most of the samples collected from April 7, 1941, to July 15, 1942 (Table 2). No collections were made in November and February. No adult specimens were observed earlier than March 29 or later than October 28. It is highly probable that had conditions been suitable for collecting during November, adults would have been observed. Table 2 shows that they were abundant on October 28, 1941, and it is considered highly improbable, except for drastic weather changes, that they disappeared in 3 days or possibly 3 weeks. Since no representatives were observed in December, the writer thinks it reasonable to place the normal seasonal population decline in the month of November. The absence of adults from December to March suggests that this species passes the winter in the egg stage. The fact that Hoff (1942) seldom found this species abundant until late May supports this contention. Furtos (1933) reported *P. smaragdina (P. smaragdina* var. *compressa)* from May until

November in Ohio. In the present study the adults reached their period of abundance in the March-October period and is typically a spring-summer-autumn form (Table (2).

TABLE 2.—*Potamocypris smaragdina.*

Date of collection	Early Instars	Late Instars	Adult	Date of collection	Early Instars	Late Instars	Adult
1941				November			
April 7	–	–	×	December 20	–	–	–
April 10	–	–	×				
April 12	–	–	×	1942			
April 16	–	–	–	January 27	–	–	–
April 19	–	–	–	February			
April 26	–	–	×	March 29	–	–	××
May 13	××	××	×	April 2	–	×	××
June 10	–	×××	××	April 7	–	–	×
July 30	–	×	××	April 27	×××	–	×
August 20	×××	××	×××	May 1	–	–	×
September 6	××	×××	×	June 20	–	–	×
September 20	×	××	××	June 27	–	–	×××
October 18	–	–	×××	July 3	–	–	×
October 28	–	–	××	July 15	–	××	–

Duration of Adult Life.—The presence of adults from March 29, 1942, to the following June 20 (84 days) warrants the assumption that early spring individuals lived until summer (Table 2). Some of the adults noted in great abundance on August 20, 1941, probably lived until the first of the following October at which time the second brood of adults became prevalent. These observations and those for the spring of 1941 (Table 2) suggest the individual life span of *P. smaragdina* adults to be from 6 to 12 weeks.

Broods per Year.—Table 2 indicates 3 broods per year for this species: 1) from possibly early February to June, 2) from April or May to September, and 3) from August to the first or possibly the middle of November.

The early instars which occurred on May 13, 1941, doubtless were the young of the proportionate number of adults taken on August 20, of the same year. Likewise the early instars collected on August 20, 1941, apparently developed into the adults which were noted on October 18 of that year. Similarly, the early instars observed April 27, 1942, were the young of adults which became numerous on June 27 of the same year. These data suggest developmental periods of 100, 60, and 62 days, respectively. The temporal discrepancies here are perhaps, in part, attributable to variations in critical environmental factors. The presence of late and early instars on May 13 and August 20 (1941) suggests that the latter were missed in collections immediately prior to these dates and explains the apparent discrepancy of 16 days in regard to appearance of early instars for the two years (1941, 1942). The present data indicates the developmental period of this species to vary from about 8½ to 14 weeks.

Previous investigators have not recorded any definite data regarding seasonal occurrence of larva for species of *Potamocypris*. Alm (1916) states that the species of this genus were so sporadic in their occurrence in Sweden, that he was unable to follow them through an entire season.

EXPLANATION OF PLATES

All drawings were made with the aid of a camera lucida from specimens mounted in Canada balsam. Plate 1, figures 1-14, is made up of drawings of adult structures; Plate 2, figures 15-25, consists of drawings of structures from various immature forms of *Potamocypris smaragdina*, *Cypriodopsis vidua*, and *Physocypria pustolosa*.

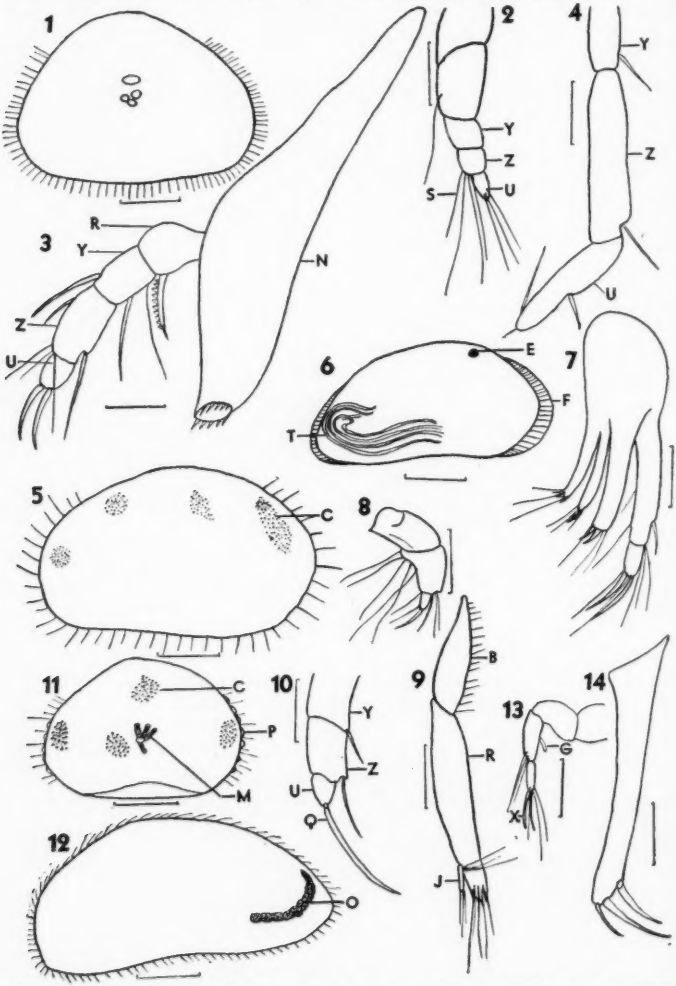

PLATE 1. Figs. 1, 11, 14. *Physocypria pustulosa* (Sharpe 1897) G. W. Müller 1912. 1.—Mesial view of the left valve. Scale: 0.14 mm. 11.—Mesial view of the right valve. Scale: 0.14 mm. M—Adductor muscle. C.—Brown spots. P—Pustules. 14.—

PHYSOCYPRIA PUSTULOSA (Sharpe, 1897) G. W. Müller, 1912

Seasonal Occurrence.—Adults of this species were collected from March 29 to September 6. They were abundant during April and again in July (1941 and 1942) with a peak abundance in April for each of these two years (Table 3). Sharpe (1897) states that *Cypria pustulosa* (*P. pustulosa* G. W. Müller, 1912) reached its greatest abundance during May, was present in very small numbers in July and August, and disappeared in September. Furtos (1933) observed that it occurred in Ohio from May to November. Hoff (1942) states that this species "reaches its greatest abundance in Illinois in June, with the individuals becoming less abundant in July and August." Kofoid (1908) noted that representatives of this species were rarely found in channel plankton in July and September. From these and the present findings it is evident that *P. pustulosa* is a spring-summer form with a seasonal range from March to September and a peak abundance in April, May (Müller), or June (Hoff) as given above, and a secondary peak in July.

TABLE 3.—*Physocypria pustulosa.*

Date of collection	Early Instars	Late Instars	Adult	Date of collection	Early Instars	Late Instars	Adult
1941				November			
April 7	–	××	××	December 20	–	–	–
April 10	–	××	××				
April 12	–	××	××	1942			
April 16	–	–	××	January 27	–	–	–
April 19	–	–	×××	February			
April 26	–	–	×××	March 29	××	–	×
May 13	××	–	×	April 2	–	–	×
June 10	–	–	×	April 7	–	–	××
July 30	–	–	××	April 27	–	–	×××
August 20	–	–	×	May 1	×	–	××
September 6	–	–	×	June 20	–	××	×
September 20	–	–	–	June 27	–	–	×
October 18	–	–	–	July 3	–	–	××
October 28	–	–	–	July 15	–	–	×

Duration of Adult Life.—The data presented in Table 3 suggest an adult life span of about 2 months for this species.

Furca. Scale: .033 mm.—Figs. 2, 3, 5, 7, 9, 13. *Cypriodopsis vidua* (O. F. Müller 1776) Brady 1867. 2.—Endopodite of the first antenna. Scale: .033 mm. Y—Antepenultimate article. Z—Penultimate article. U—Ultimate article. S. Natatory seta. 3.—Mandible and mundibular palp. Scale: .033 mm. N—Mandible. R—Protopodite of mandibular palp. Y—Antepenultimate article of the palp. Z—Penultimate article of palp. U—Ultimate article of palp. 5.—Mesial view of the right valve. Scale: .033 mm. C—Green band. 7.—Left maxilla. Scale: .033 mm. 9.—First thoracic appendage. Scale: .033 mm. B—Branchial plate. R—Protopodite. J—Palp. 13.—Second antenna. Scale: 0.15 mm. G—Club-shaped sensory seta. X—Claw.—Figs. 4, 6, 8, 10, 12. *Potamocypris smaragdina* (Vávra 1891) Daday 1900. 4.—Third thoracic appendage. Scale: .033 mm. Y—Antepenultimate article. Z—Penultimate article. U—Ultimate article. 6.—Lateral surface of the left valve. Scale: 0.14 mm. F—Flanges. E—Compound eye. T—Testes. 8.—Mandibular palp. Scale: .033 mm. 10. Second thoracic appendage. Scale: .033 mm. Q—Spine. Y—Antepenultimate article. Z—Penultimate article. U—Ultimate article. 12.—Lateral view of right valve. Scale: 0.14 mm. O—Ovary.

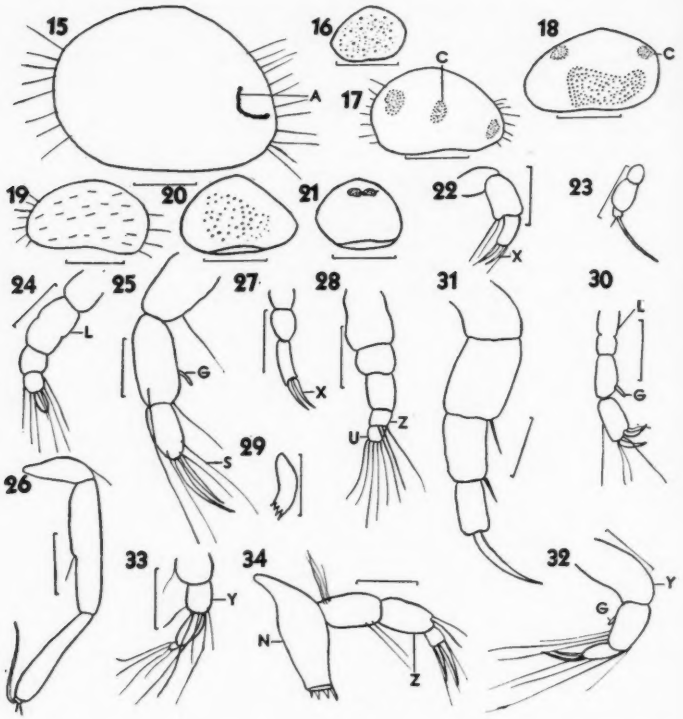

PLATE 2. Figs. 15, 21, 27. *Physocypria pustulosa* (Sharpe 1897) G. W. Müller 1912. 15.—Instar VII. Mesial view of the left valve. Scale: 0.14 mm. A—Anlage of the ovary. 21.—Instar II. Left valve. Scale: .08 mm. 27.—Instar I. Second antenna. Scale: .033 mm. X-Claw.—Figs. 16, 17, 18, 20, 28, 32. *Cypriodopsis vidua* (O. F. Müller 1776) Brady 1867. 16.—Instar III or IV. Mesial surface of left valve. Scale: 0.19 mm. 17.—A middle instar. Lateral view of the right valve. Scale: .033 mm. C—Green band. 18.—Instar VI. Lateral view of left valve. Scale: .033 mm. C—Green band. 20.—Instar IV. Lateral view of left valve. Scale: 0.14 mm. 28.—Instar III. First antenna. Scale: .033 mm. U—Ultimate article. Z—Penultimate article. 32.—Instar III or IV. Second antenna. Scale: .033 mm. G—Club-shaped sensory seta. Y—Antepenultimate article.—Figs. 22-26, 29-31, 33, 34. *Potamocypris smaragdina* (Vávra 1891) Daday1900. 19.—Instar V. Lateral view of left valve. Scale: 0.14 mm. 22.—Instar I. Second antenna. Scale: .033 mm. X—Claw. 23.—Instar IV. Second thoracic appendage. Scale: .033 mm. 24.—Instar V. First antenna. Scale: .033 mm. L—Second article (dividing). 25.—Endopodite of the second antenna. Scale: .033 mm. G—Club-shaped sensory seta. —Natatory seta. 26.—Third thoracic appendage. Scale: .033 mm. 29.—Instar I. Mandible. Scale: .033 mm. 30.—Instar V. Second antenna. Scale: .033 mm. G—Club-shaped sensory seta. L—Basal article (dividing). 31.—Instar VII. Second thoracic apendage. Scale: .033 mm. 33.—Instar I. First antenna. Scale: .033 mm. Y—Antepenultimate article. 34.—Instar VII. Third cephalic appendage. Scale: .033 mm. N—Mandible. Z—Penultimate article.

Broods Per Year.—*P. pustulosa* apparently has 2 broods per year; 1) late March to June, and 2) May to September. Corresponding, or approximately corresponding adult frequencies with reference to the early instars of May 13, 1941, March 29, 1942, and May 1, 1942, were observed on July 30, April 27, and July 3, respectively, for the same years. This suggests developmental periods of 79, 30, and 64 days or from about 4 $^1/_3$ to 11 weeks and that the organism passes through the winter in the egg stage.

Summary

1. The literature reveals no strictly seasonal life-history studies for North American freshwater Ostracoda.

2. Over 400 collections of ostracods were taken from Round Lake (artificial pond) for more than fifteen months (April 7, 1941-July 15, 1942) in order to keep variable factors at a minimum. The habitat, located in Forest Park, St. Louis, Mo., is fed primarily by city water mains, is about 100 feet in diameter, and varies in depth from a few (4-5) inches peripherally to about 6 feet at the center where an overflow pipe removes the excess water.

3. Laboraotry cultures were kept as controls on field observations. Morphological observations were made from alcohol-preserved and mounted specimens for both developmental individual stages and adult specimens.

4. Seasonal life histories of 1) *Cypriodopsis vidua* (O. F. Müller, 1776) Brady, 1867, 2) *Potamocypris smaragdina* (Vávra, 1891) Daday, 1900, and 3) *Physocypria pustulosa* (Sharpe, 1897) G. W. Müller, 1912, were observed and recorded.

5. The following observations apply to the above species in Round Lake:

a) *Cypriodopsis vidua* has a seasonal range (adults) from March to December, a brood from April to September and another from August to the following April, a peak of abundance in June or July, and October, and is a typical summer-autumn form. Nine to 15 weeks are required for completion of larval development and adults live from 3½ to 6 months.

b) *Potamocypris smaragdina* has a seasonal range from March to November; a brood from possibly early February to June, another from April or May to September, and a third from August to possibly the middle of November; a primary peak of adult abundance in June, August, and October; and is a spring-summer-autumn form. Eight and one-half to 14 weeks apparently are required for completion of larval development, and the adult life span is from 6 to 12 weeks.

c) *Physocypria pustulosa* has a seasonal range from late March to early September, a brood from late March to June and another from May to September, a primary peak of abundance in April, a secondary peak of abundance in July, and is a spring-summer form. Four and one-third to 11 weeks are required for completion of larval development and the adult life span is approximately 2 months.

6. *Physocypria pustulosa* which is a spring-summer form, has 2 annual broods, a comparatively short developmental period, and a relatively short adult life span whereas *Cypriodopsis vidua* and *Potamocypris smaragdina* are summer-autumn and spring-summer-autumn species (resp.), have 2 and 3 (resp.) annual broods per year, longer (average) developmental periods, and longer (average) adult life spans.

7. The presence of males and females of *P. smaragdina* and *P. pustulosa* during the entire period of seasonal occurrence of adults, suggests that reproduction is always syngamic in these and possibly other freshwater ostracod species in which males and females are regularly found, and that no alternation of parthenogenetic and syngamic reproduction occurs.

8. Only females of *C. vidua* were observed.

9. Several hundred measurements for maximum length and maximum height of shells indicate male individuals to be smaller than females but since the two groups overlap, shell size alone is not a valid criterion of sex in *P. smaragdina* and *P. pustulosa*.

10. Structures with regard to sexual dimorphism are reviewed.

11. Suggested problems for further investigations are those concerned with movement of ostracods with reference to wind, water currents, temperature, and favorable local habitats. These apparently contribute to sporadic or "spotty" distribution of these animals.

12. The number of molts and successive appearance of appendages and other structures are recorded.

13. There are 8 pairs of appendages, including the furca, in the Ostracoda. The first 3 pairs are present at hatching; the addition of the 5 other pairs occurs during development from the nauplius to the sexually mature adult which involves 8 successive molts. The greatest number of articles added to a single appendage is three in the 1st antennae, and also in the 2nd antennae of some species. The antennae reach their definitive form during the 7th instar, hence only 3 podomeres are added during 6 molts. It was also observed that some appendages, for example the 3rd thoracic, appear in one instar and reach the definitive form during the next. A pair of appendages and/or a podomere are not added during each successive molt in the freshwater Cypridae as maintained for many arthropods.

14. The addition of podomeres to the 1st and 2nd antennae results from the division of the basal and 2nd articles in *C. vidua, P. smaragdina,* and *P. pustulosa*.

15. The mandible in the nauplius of *P. smaragdina* and *P. pustulosa* except for size, is similar to that of the adult. No evidence of the 3-segmented pediform stage of the mandible was seen in any of the species studied. The anlagen of the reproductive glands appear during the 7th instar; the sexually mature animal appears after ecdysis of the 8th instar.

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Notes on South Carolinian Reptiles

Edmund V. Malnate

Short visits to the Santee river region of South Carolina in May, 1937, and May, 1938, resulted in collections totalling 107 specimens of reptiles, representing 31 forms. The area visited is the vicinity of Alvin, Berkeley county, 7 miles southeast of St. Stephen on highway SC 45, and within the limits of the Frances Marion National Forest. The terrain is low; St. Stephen is only 75 ft. above sea level, and the bottom of the Santee river and its tributaries is a flood plain often extensively submerged. The slight higher land pinewoods of the higher ground, with their modification by agriculture.

The principal plant formations are the swamp forest of the bottomland and the hardwood association of the swamp border; and the moist and dry pinewoods of the higher ground, with their modification by agriculture.

I wish to express my appreciation to the people of St. Stephen for their interest and assistance, and particularly to Mrs. Ruth Edens, postmistress of Alvin, for gracious hospitality extended me on my visits. Edward MacBride and Ernest Turner, of St. Stephen, are responsible for specimens obtained along the Santee canal. I am indebted to various colleagues for aid in the preparation of this report.

Fifty-three specimens have been presented to the Carnegie Museum, and two to the Charleston Museum. My annotated list of species follows.

Alligator mississipiensis (Daudin).—A young individual was captured in the Santee canal. The alligator is reported by local fishermen to be seen occasionally in the Santee river, but is found usually in the more inaccessible portions of the swampforest.

Anolis carolinensis Voight.—Three male and three female specimens were taken near Alvin, May 17-18. The females, measuring 130-140 mm., contained developing eggs.

The anole is the most common lizard in the region. I have observed several battles between males and these have varied considerably in behavior pattern. To present briefly two extremes: (1), without preliminaries two males rush from opposite ends of a fence rail and collide with such violence as to throw both to the ground; one disappears into the ground rubble, while the other climbs back to the top of the fence, fan extended, head bobbing; (2), a single male sunning itself is seen to assume the typical belligerent attitude toward a second male that appears on the fence, and for fifteen minutes the two challenge and strut, gradually closing the distance between them, until, when but a span apart, the newcomer disappears over the far side of the fence.

Sceloporus undulatus undulatus (Latreille).—Four specimens from the vicinity of Alvin have 35, 36, 37, and 38 dorsal scale rows from the occiput to a point above the vent. The Santee river area is evidently in the area of intergradation between *undulatus undulatus* and the more wide-ranging *undulatus fasciatus* (Smith, 1938, Occ. Papers Univ. Mich. Mus. Zool., 387: 1-17). Two females, 145 mm. and 136 mm., contained five and eight developing eggs, respectively.

Ophisaurus ventralis (Linnaeus).—Two specimens, one from the Santee canal, 1 mile S. of St. Stephen, one from the vicinity of Alvin. Both individuals were taken above ground in damp situations. When pursued, the species moves rather rapidly, throwing out stiff and awkward lateral undulations. It bites vigorously when captured. The dorso-lateral folds were infested heavily with ticks and red mites.

Cnemidophorus sexlineatus sexlineatus (Linnaeus).—A single specimen from the vicinity of Alvin. This lizard is restricted to the open and grassy portions of the dry pinewoods, where it is abundant.

Leiolopisma unicolor (Harlan).—The diminutive ground lizard was found only under leaves or bark, or in rotten logs in the damp woods. One specimen was taken near Alvin.

Eumeces fasciatus (Linnaeus).—Two specimens from moist pinewoods in the vicinity of Alvin.

Eumeces inexpectatus Taylor.—One specimen from the vicinity of Alvin, from beneath a log in dry pinewoods.

Eumeces laticeps (Schneider).—Two specimens from the swamp edge forest in the vicinity of Alvin. One female, 96 mm. snout to vent, with twelve developing ova.

Dr. Edward H. Taylor kindly has checked the identification of the Eumeces. The ecological relations of three closely related species of the genus in the same area obviously presents problems for observation.

Farancia abacura abacura (Holbrook).—A large example of the eastern mud-snake was taken in the swamps bordering the Santee canal and a small, smashed and dried specimen was found on a road across a swampy creek tributary to the Santee river.

Diadophis punctatus punctatus (Linnaeus).—Three specimens from Alvin, taken in the moist woods and the swamp edge; one specimen was found coiled in the mud under a bark slab submerged in approximately 1.5 inches of water in the shallows of a swamp pool.

Rhadinaea flavilata (Cope).—Three specimens from Alvin constitute the second state record and have already been reported (1939, Zoologica, 24: 359-366).

Heterodon contortrix (Linnaeus).—Three specimens from the Santee canal, 1 mile S. of St. Stephen. One specimen, female, 676 mm., with 16 eggs.

Two specimens are of the normal blotched pattern, with orange interspaces anteriorly. The third is melanistic, with dorsal color black, underparts gray-white, lateral edges of ventrals clouded darker gray, and the head pattern faintly discernible.

Heterodon simus (Linnaeus).—Four specimens from the Santee canal, 1 mile S. of St. Stephen, all males. The largest specimen measures 365 mm.

The pattern of *sinus* is similar to that of *contortrix,* but it lacks the brilliant orange interspaces of the latter and the contrast between pattern and ground-color is less sharp.

Opheodrys aestivus (Linnaeus).—A single specimen was captured on the ground of a raised ridge along the river bank, 5 miles SE. of St. Stephen. Within the town of St. Stephen, this beautiful snake is found occasionally in trees and shrubbery.

Coluber constrictor constrictor (Linnaeus).—Five specimens from Alvin and the vicinity of the Santee canal. The blacksnake was observed in all types of habitat excepting the more open portions of the pineland.

Elaphe quadrivittata quadrivittata (Holbrook).—Three specimens from the Santee swamp, in the vicinity of Alvin and near St. Stephen.

The capture of three specimens of *quadrivittata* of assorted sizes permits observation on the change of pattern with increasing age:

Specimen	*Size*	*Blotches*	*Stripes*
1	1219 mm.	distinct	distinct
2	1498 mm.	weak	strong
3 (capt.)	1619 mm.	faint	dominant
4 (death)	1978 mm.	lacking	sole pattern

Lampropeltis triangulum elapsoides (Holbrook).—A single specimen was taken in a rotten tree stump in an open section of pinewoods at Alvin.

Lampropeltis getulus getulus (Linnaeus).—Specimens from the vicinity of Alvin were taken in rather open woods close by the swamp-edge. It is interesting to note that both specimens "froze" on being approached. The two snakes were infested heavily with red mites.

Cemophora coccinea (Blumenbach).—A DOR from the highway at its crossing of the Santee swamp north of St. Stephen.

Natrix erythrogaster erythrogaster (Forster).—A single specimen from 5 miles W. of Jamestown; two individuals from the Santee canal, 1 mile S. of St. Stephen.

Natrix sipedon fasciata (Linnaeus).—Two specimens from the Santee canal, 1 mile S. of St. Stephen.

Natrix taxispilota (Holbrook).—Specimens were taken in the Santee swamp, near St. Stephen, and on the Santee river, 5 miles SE. of St. Stephen.

Storeria occipitomaculata (Storer).—Three specimens were taken under wood chips in the damp pinewoods near Alvin.

Thamnophis sirtalis sirtalis (Linnaeus).—One gartersnake was captured in the Santee canal area.

Agkistrodon mokeson austrinus Gloyd and Conant.—Two individuals taken at Alvin; a third specimen taken on the Santee road, 4 miles SE. of St.Stephen, contains in its stomach a nymphalid caterpillar.

Agkistrodon piscivorus piscivorus (Lacépède).—Two specimens from the Santee canal, 1 mile S. of St. Stephen; one from the swampforest near Alvin.

Sistrurus miliarius miliarius (Linnaeus).—A specimen from the Santee canal, 1 mile S. of St. Stephen. The pygmy rattler is reported as occurring within the town limits of St. Stephen.

Kinosternon subrubrum subrubrum (Lacépède).—Three examples were taken in the damp woods, one within a hollow stump in company with a snake (probably *Lampropeltis g. getulus*).

Chelydra serpentina serpentina (Linnaeus).—A very large specimen was discovered under a log close by a sluggish stream in the Santee swamp near Alvin.

Pseudemys scripta (Schoepff).—Abundant in the Santee swamp, near Alvin.

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Scolecodonts of the Silurian Manitoulin Dolomite of New York and Ontario*

E. R. Eller

Introduction

One of the formations which is well exposed along the Niagara escarpment in New York and Ontario is the Manitoulin dolomite, a member of the lower Silurian Cataract or Albion group. In the southern portion of its outcrop the Manitoulin overlies the Whirlpool sandstone; in the northwestern part, it overlies Queenston shales. In both areas it is overlain in turn by shales of the Cabot Head formation.

A preliminary paper (Eller 1940) has described scolecodonts, or fossils polychaete annelid jaws, from Manitoulin beds of the Niagara Gorge. Later discoveries at localities ranging from Pekin, New York, to Manitoulin Island indicated that these fossils were widely distributed. This was important since earlier studies had dealt only with scolecodonts of restricted areas in which neither their geographic range nor stratigraphic limits could be determined. This study therefore was undertaken in order to determine the distribution of these fossils in the Manitoulin, their index value, and their relationship to changes in the sediments.

Collections and studies were made at more than 50 outcrops of the Manitoulin, but only 22 well-spaced sections are presented in this study. From 25 to 100 pounds of rock were selected from the complete thickness of each outcrop. This material, except that from the Niagara Gorge and Pekin, New York, was immersed in a weak solution (about 5 per cent) of cold hydrochloric acid. The carbonates dissolved readily, leaving a residue of silt, quartz, scolecodonts, and other minerals and fossils. The material from the Niagara Gorge and Pekin was dissolved in hydrofluoric acid.

The writer is deeply indebted to Mr. David Seaman of the Section of Invertebrate Paleontology, Carnegie Museum, for his assistance in dissolving the material and separating faunas from the residues. Completion of the field work was supported by a grant from the Penrose Bequest of The Geological Society of America.

Previous Work

As early as 1821 Bigsby (1821, 1824) classified the rocks of Manitoulin Island as the "Limestones of the Manitoulin Range," while Amos Eaton (1824, 1830) was the first geologist to study Silurian strata in the Lewiston

* The plates accompanying this article were courteously released by the Carnegie Museum.—The Editor.

area and Conrad (1837) reported on the Niagara River section. Houghton (1840) assigned the "Lower Limerock and Shales" and the "Upper Limerock" to formations we now know as Ordovician and Devonian of Manitoulin Island and adjacent territory. Vanuxem (1840) gave the name Medina to the red sandstone of Oswego County. Hall (1840) used the terms Medina sandstone, red shale, and marl for the lowest rocks in the Fourth District from Wayne County to the Niagara River and a few miles west of Toronto. W. B. and H. D. Rogers (1843) traced the lower Silurian beds in Ontario and Ohio; Murray (1843) mapped the Niagara escarpment, continued his work for several years (1849), and traced formations of the Niagara escarpment through the Ontario Peninsula and across Manitoulin Island.

Hall (1843) continued to study the beds and fauna of the Niagara district and several localities in Ontario and nine years later Hall (1852) divided Silurian strata into the Clinton, Niagara, and Onondaga Salt groups but the lower sandstone (Whirlpool) was erroneously considered to be of Clinton age. Logan (1863) summarized previous work but did not extend the Medina beyond the Niagara area. Northwest of Dundas, he considered the sandstone (Whirlpool) to be the Grey Band (Thorold) and therefore erroneously described the limestone and shale overlying it as Clinton in age. The Manitoulin Islands were studied by Bell (1869, 1870) who assigned their Silurian strata to the Clinton and Niagara formations. Nicholson (1874) described his Medina fossils as belonging to the Clinton, and the annelid jaws described by Hinde (1879) probably were collected from lower Medina beds instead of from the Clinton. Bell (1898) discussed the strata of Manitoulin Island and measured their thickness, but included all the rocks between the Niagara and Hudson River in the Clinton formation. Grabau (1901) placed all red sandstones, shales, and white sandstones exposed in the lower Niagara Gorge in the upper Medina. The red shales he placed in the lower Medina but later (Grabau 1905) transferred them to the Ordovician.

In his description of the Rochester and Ontario Beach quadrangles, Hartnagel (1907) divided the Medina into two lithological units. In the Niagara region the red shales were included in the lower Medina while 25 feet of gray sandstone followed by shales and thin-bedded sandstones were placed in the upper Medina. In a revised classification, Grabau (1909) called these red shales the Queenston formation, stating that it was a phase of the Richmond. The heavy sandstone layer lying directly above it was called the Whirlpool. Work on the Monroe formation by Grabau and Sherzer (1910) opened the question of the proper interpretation of the lower Silurian. Schuchert (1910) found the earliest Silurian fauna in the upper Medina of the Niagara Gorge, while faunas at Hamilton, Dundas, and Flamborough Head (usually referred to the Clinton) were found in the position of the Medina.

A clearer conception of the stratigraphy of the southwestern peninsula of Ontario resulted from preparations for the Twelfth International Geological Congress held at Toronto in 1913. At the meeting of the Paleontological Society, Schuchert (1912) proposed the name Cataract for what had been regarded as Clinton in Ontario. The Niagara escarpment was fully studied in

1912 by Williams (1913) who proposed the name Manitoulin for argillaceous dolomites resting on the Whirlpool sandstone in the Niagara region and for dolomite beds overlying the Queenston shales in the Bruce Peninsula and Manitoulin Island. Grabau (1913) also used the name Keppel for the dolomites resting on the Queenston shales in the Bruce Peninsula, between Owen Sound and Cape Commodore on Georgian Bay, Lake Huron. For the red and green shales lying above the Manitoulin dolomites, the name Cabot Head (Grabau 1913) later was proposed for the preoccupied Kagawong of Williams (1913). Parks (1913) described the Cataract section at Forks of the Credit and Cataract Junction, Ontario, distinguishing a lower sandstone, a middle limestone, and an upper shale.

Clarke suggested Albion for beds above the Queenston shales (Ulrich 1919), and the name was used by Kindle and Taylor (1913) for strata between the Queenston and Clinton. This was explained by Kindle (1914) in a footnote which said that the name was suggested by the United States Geological Survey's committee on geologic names. Schuchert (1914) described the Cataract in more detail and gave sections from the Niagara Gorge to Cabot Head, Ontario, and Williams (1919) published a general account of the Silurian in this area. Williams (1937) also published a preliminary report on the general geology and petroleum possibilities of Manitoulin Island, Ontario, and Eller (1940) described the scolecodont fauna of the Manitoulin in the Niagara Gorge. The vicinity of Hamilton and Toronto was mapped by Caley (1940). In the *Correlations of the Silurian Formations of North America* (Swartz et al., 1942), the Manitoulin beds appear on the correlation chart but are not discussed in the annotations. In western New York the formation is called the Manitoulin shale of the Albion group and in southern Ontario as the Manitoulin dolomite of the Cataract group, both being placed in the Albion series. The Manitoulin is correlated with the Brassfield limestone in the Central States and the Mississippi Valley.

Distribution

Along the Niagara escarpment the Manitoulin beds form a narrow belt which extends in a southwestward direction from Manitoulin Island across the Ontario Peninsula to New York. On Manitoulin Island the beds often form a smaller escarpment which is secondary to that of the Lockport dolomite. Good exposures are found at the Niagara Gorge, Stoney Creek, Hamilton, Dundas, in the vicinity of Georgetown, Forks of the Credit, Cataract,

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PLATE 1

Fig. 1. Manitoulin dolomite at the Forks of the Credit, Ontario.

Fig. 2. Manitoulin dolomite in a quarry at Owen Sound, Ontario, showing weathering and cherty layers.

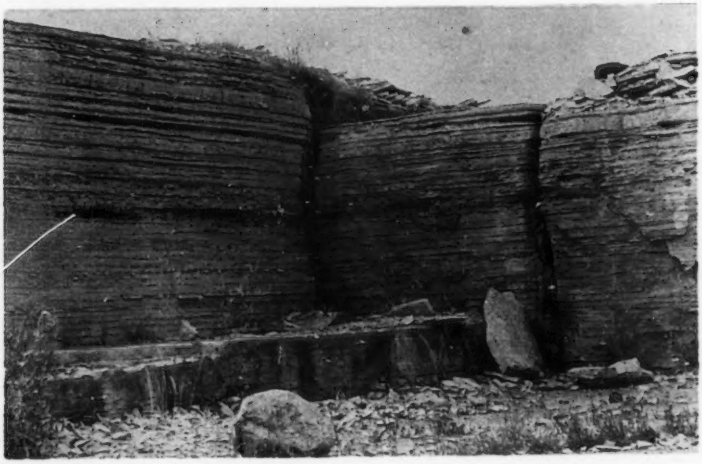
PLATE 2

Fig. 1. Manitoulin dolomite (B) and Richmond (A) in contact near Kagawong, Manitoulin Island, Ontario.

Fig. 2. Bioherm in the Manitoulin dolomite on the Gore Bay-Manitowaning road, Manitoulin Island, Ontario.

AMER. MIDL. NATUR. 32(3), Nov. 1944, facing p. 734.

PLATE I



AMER. MIDL. NATUR. 32(3), Nov. 1944, facing p. 734.

PLATE 2

Orangeville, and along the Beaver River. From Owen Sound northward to Cabot Head, many continuous but not complete sections are found. On Manitoulin Island, the type locality, many excellent outcrops are available and thes trata forms a cuesta in many parts of the Island.

Origin

Grabau (1913) considered the Manitoulin, or Keppel, in the Bruce Peninsula to be an early marine deposit whose sediment was derived by erosion of folded Ordovician red beds of the Appalachian providence. Schuchert (1914) concluded that the sediments spread westward from the St. Lawrence embayment and that a shoal, a sandy area, or a delta (Medina) separated the Manitoulin and Brassfield seas. So many species seem to be common to both formations that a complete barrier cannot be inferred. The facts that the southeastern Manitoulin consists of a detrital material containing ripple-marked layers and that the formation thickens and becomes increasingly calcareous northwestward seem to suggest that the sediments were derived from an upraised Apalachia to the southeast or east. The Cabot Head shales overlying the Manitoulin dolomites show an increase in clastic sediments.

Thickness

The true thickness of the Manitoulin is difficult to determine since it grades gradually into the Cabot Head shales. Measured sections at Niagara Gorge are about 24 feet and in the Ontario Peninsula range from 20 to perhaps 40 feet. On Manitoulin Island the beds reach as much as 60 feet and include bioherms of cryptostomatous bryozoans. The strata vary in thickness from thin to medium except at the bioherms, where they are massive (Plates 1 and 2). In the southeastern part of the section the basal beds are usually thickest. At Owen Sound the face of the quarry wall shows the uniform thickness of the beds and the uneven weathering that is taking place. On Manitoulin Island the thicker bedding is often at the top.

Lithology

The Manitoulin dolomite at the type locality on Manitoulin Island is white to gray or bluish gray, thin to medium bedded, medium to fine grained, compact, and semi-crystalline. On Bruce Peninsula, especially southeast of Collingwood, the beds are increasingly impure. Sandy and shaly layers are common and at the Niagara Gorge very little limy material is found. At Pekin, New York, the beds are ripple-marked and unevenly bedded. From the vicinity of Collingwood northwestward the Manitoulin beds often form a secondary escarpment and have been quarried for road and building materials. The beds of the Manitoulin weather to a buff and gray color and are sometimes stained with iron.

Williams (1913) named and described the Manitoulin formation as a fine-grained, hard and light blue-gray dolomite, weathering to gray and buff, At the Niagara Gorge the dolomites are represented by calcareous shales and arenaceous limestones or calcareous sandstones. Goudge (1938) lists the Mani-

toulin as the principal dolomite band of the Medina Cataract formation on Manitoulin Island and Bruce Peninsula. He mentions that it becomes increasingly sandy and shaly to the southwest. Since the rock dissolves rapidly in a weak, cold solution of hydrochloric acid, the question arises as to whether it should be classified as a dolomite. Goudge (1938) defines a dolomite as a rock composed almost wholly of the mineral dolomite which contains between 40 and 45.65 per cent magnesium carbonate. Any rock, in which calcium carbonate predominates and in which the magnesium carbonate is less than 10 per cent is considered a limestone; all rocks in which the magnesium carbonate is between the two percentages given above are called magnesian limestone. In a chemical study of dolomites Knight (1921) lists analyses of samples of wide distribution. The percentage of magnesium carbonate ranges from 37.82 to 46.80. An ideal dolomite is listed as containing 54.35 per cent calcium carbonate and 45.65 per cent magnesium carbonate. Goudge (1938) gives the percentage of magnesium carbonate of the Manitoulin dolomite from various localities as follows: Credit Forks, Ontario, 35.72; Owen Sound, Ontario, 39.11; Gore Bay, Manitoulin Island, 42.74; Excelsior, Manitoulin Island, 42.04. Williams (1919) gives the magnesium carbonate content of the Manitoulin dolomite as 20.54 per cent at Mitchell's Mills, near Collingwood, Ontario, and 23.95 per cent in the Niagara Gorge. From 25 to 50 pounds of material from these localities were dissolved readily in a weak, cold solution of hydrochloric acid. Perhaps the formation should be called a magnesian, or dolomitic, limestone, at least on Bruce Peninsula and southeastward. However, the term Manitoulin dolomite has been used in the literature so long that it is probably best to continue it although it does not always accurately describe the rocks.

Structure

The Manitoulin dolomite is part of a relatively simple structure with some small undulations. Since most of the area is covered by a mantle of glacial drift, it is difficult to determine structural details.

In the region of the Niagara River the direction of the dip is slightly southeast, toward the Appalachian geosyncline. At Hamilton the dip is nearly south, but northwest along Bruce Peninsula and Manitoulin Island dips are generally southwestward toward the Michigan basin. The regional dip in the southeastern part of the horizon, based on well records by Caley (1940), averages about 33 feet to the mile. In the northern part the dip increases slightly.

The Cincinnati arch extends through Ontario in a northerly direction and crosses the Manitoulin dolomite south of Collingwood. It is at this point that the Whirlpool sandstone pinches out and that somewhat farther north the Dyers Bay dolomite appears. Pirtle (1932) points out the fact that the arch was an important factor in partly isolating the Michigan basin during several periods following its origin and that the saddle between it and the Appalachian geosyncline in the vicinity of Lake St. Clair may have an important bearing on the faunal history. As far as the scolecodont fauna is concerned, the arch

probably did not form a complete barrier since the same species are well represented along the complete length of the Manitoulin dolomite member on both sides of the arch.

In northern outcrops of the Manitoulin, lithologic and faunal changes are quite noticeable. The beds thicken and bioherms are present on Manitoulin Island. In the upper part of the member new faunal elements are present, many of which are probably new. It is possible that the upper beds will be considered as a separate member. The scolecodont fauna is, however, well distributed throughout the formation.

Description of Sections

GENERAL STATEMENT

As much as possible, sections were studied at regular intervals to permit detection of possible changes in scolecodonts, lithology and stratigraphy. Where practicable, measurements were made with a hand level and tape. The exact thickness of the Manitoulin beds seldom can be determined lithologically, since the upper portions become detrital and blend into the Cabot Head shales. Their position at the base of the steep Niagara escarpment, especially in the southern part of the Ontario Peninsula, often causes them to be partly covered. Northwestward, on Bruce Peninsula and Manitoulin Island, the upper layers are usually glaciated and partly removed. Striations and highly polished surfaces are often encountered. The location of the sections is shown on the accompanying may, plate 3, by a cvross in a circle, and with a nearby settlement or geographical feature named.

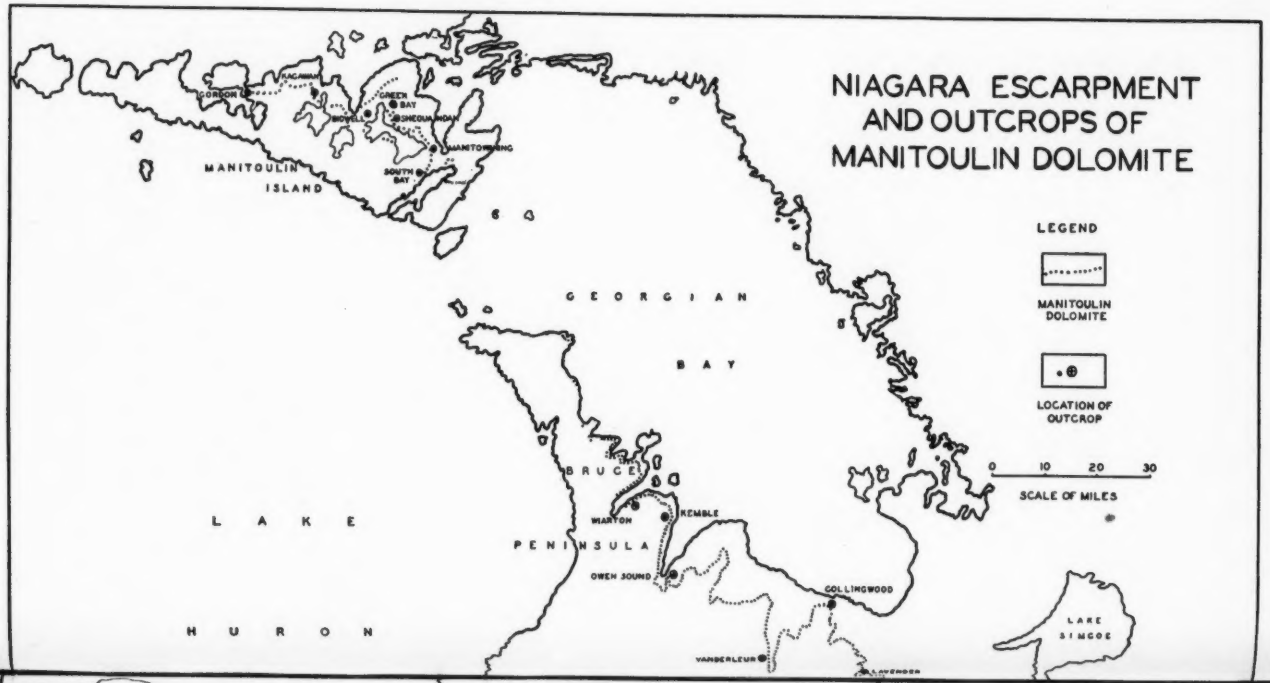
Sections in New York

PEKIN, NEW YORK

At a new quarry in the Whirlpool sandstone on the lower escarpment northwest of Pekin, New York, several feet of shale and sandstone proved rich in Manitoulin scolecodonts. The Whirlpool is capped by about 18 inches of black, thin shale. A layer of impure sandstone, varve-like in appearance, overlies the shale. Along the face of the quarry this layer varies in thickness from a few inches to more than a foot. Numerous jaws were found in the sandstone, especially on the surface. Above this layer is a 12-inch layer of black shale overlain by a rust-colored, impure, calcareous layer about 18 inches in thickness. The scolecodont fauna includes:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites fornicatus Eller
Œnonites peracutus Eller
Ildraites peramplus Eller
Ildraites geminus Eller
Ildraites horridus Eller
Ildraites patulus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Arabellites plenidens Eller
Arabellites oviformis Eller
Paleononites parallelus sp. nov.
Staurocephalites pyramis sp. nov.
Staurocephalites externus sp. nov.
Diopatriates fustis Eller

After dissolving the sandstone in hydrofluoric acid, the residue consisted of scolecodonts, graphite, pyrite, muscovite and partly dissolved quartz grains.


NIAGARA ESCARPMENT
AND OUTCROPS OF
MANITOULIN DOLOMITE
LEGEND
MANITOULIN DOLOMITE
LOCATION OF OUTCROP
0 10 20 30
SCALE OF MILES
MANITOULIN ISLAND
GEORGIAN BAY
LAKE HURON
BRUCE PENINSULA
WIARTON
KEMBLE
OWEN SOUND
COLLINGWOOD
LAKE SIMCOE
VANDERLEUR
GLEN CROSS
ORANGEVILLE

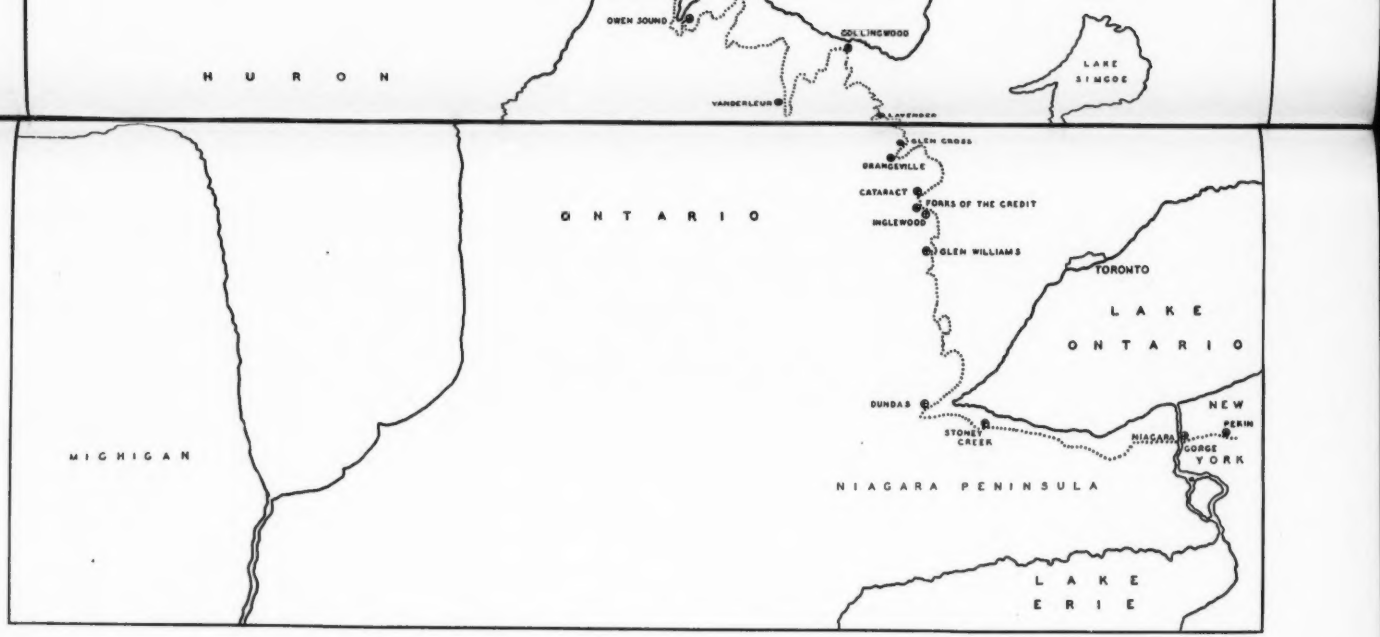

HURON
OWEN SOUND
COLLINGWOOD
LAKE SIMCOE
VANDERLEUR
GLEN CROSS
BRANGESVILLE
CATARACT
FORKS OF THE CREDIT
INGLEWOOD
GLEN WILLIAMS
ONTARIO
TORONTO
LAKE ONTARIO
DUNDAS
STONEY CREEK
NIAGARA GORGE
NEW
PERIN
YORK
NIAGARA PENINSULA
MICHIGAN
LAKE ERIE

PLATE 3

NIAGARA GORGE, NEW YORK

On the east side of the Niagara River near the mouth of the Niagara Gorge and about a half a mile from Lewiston, New York, Manitoulin beds contain a large variety of scolecodonts. Along the tracks of the Lewiston branch of scolecodonts, graphite, pyrite, muscovite and partly dissolved quartz grains. wall, the complete thickness of the Manitoulin may be observed. On top of the Whirlpool sandstone there are several inches of shale. Above the shale is an 8-inch layer of calcareous sandstone which splits or weathers into thin layers. On top of this bed are several thin sandy layers containing scolecodonts. Next come about 6 feet of shale; then intermittent layers of sandy material and shale, one of whose upper layers contains scolecodonts. It is difficult to determine the upper limit of the Manitoulin, but because of the jaws its thickness is estimated at about 24 feet. Scolecodonts are very plentiful at this locality, the following species having been described:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites parvidentatus Eller
Œnonites levis Eller
Œnonites albionensis Eller
Œnonites coalescens Eller
Œnonites staufferi Eller
Œnonites fossulus Eller
Œnonites kopfi Eller
Œnonites fornicatus Eller
Œenonites peractus Eller
Œnonites flexus Eller
Œnonites exactus Eller
Œnonites permistus Eller
Œnonites lewistonensis Eller
Œnonites bidens Eller
Œnonites triangulus Eller
Œnonites ? franci Eller
Œnonites acinaces Eller
Ildraites geminus Eller
Ildraites horridus Eller
Ildraites duplex Eller
Ildraites peramplus Eller
Leodicites variedentatus Eller
Arabellites oviformis Eller
Arabellites plenidens Eller
Arabellites rectidens Eller
Eunicites vertex Eller
Eunicites petasus Eller
Diopatraites fustis Eller

The rock from this locality was dissolved in hydrofluoric acid and the jaws were recovered by the use of heavy liquids (Eller 1941). The residue consisted, in addition to the well-rounded and etched quartz grains, of a small amount of pyrite and graphite.

Sections in Ontario and Bruce Peninsula

STONEY CREEK, ONTARIO

In a gorge in the village of Stoney Creek, Ontario, near the Toronto, Hamilton, and Buffalo Railroad, the Manitoulin contains about 20 feet of well-exposed magnesian limestone and shales. The thick basal beds contain green mud galls, while shale partings prevail in the upper beds. Fossils are plentiful throughout the beds, the following scolecodonts being common:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites kopfi Eller
Œnonites lewistonensis Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Staurocephalites pyramis sp. nov.
Staurocephalites externus sp. nov.
Eunicites petasus Eller
Diopatraites fustis Eller

Samples of the rock were taken throughout the section; they dissolved readily in hydrochloric acid, leaving a residue of gray and white sand grains, considerable pyrite, and grains of rough, clear quartz. A small amount of graphite, rose quartz, and tiny silicified crinoid columnals were present.

DUNDAS, ONTARIO

In the valley of Spencer Creek, almost 30 feet of the Manitoulin member are found. The uppermost 20 feet consists of calcareous shales and limestones with more massive beds having shale partings in the lower part. The lowest 9 feet of the section are more sandy with shale partings. Fossils are common at this locality, especially in the lower strata. This may be the horizon in which Hinde (1879) found annelid jaws. The following scolecodonts have been identified:

Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites parvidentatus Eller
Arabellites rectidens Eller
Staurocephalites externus sp. nov.

A large amount of material from this locality was treated with acid; the residue consisted of buff-colored silt, pyrite, and white and iron-stained quartz grains.

GLEN WILLIAMS, ONTARIO

Whirlpool sandstone is being taken from the Sykes quarry just outside Glen Williams. About 12 feet of Manitoulin beds are present there and in the adjacent Norton Quarry. They rest upon Whirlpool sandstone. The lower beds of the Manitoulin are a gray, sandy, shale which gives way at various places along the face of each quarry to ripple-marked calcareous sandstone. Thin shale and sandy layers follow, which form a solid layer 12 to 16 inches thick at various places. Following upward are thin shales, calcareous sandstone and magnesian limestone layers, the latter prevailing in the upper half. One prominent layer, 8 to 12 inches thick, contains large cavities which are mostly filled with a pink form of celestite. This same layer is well developed at the Forks of the Credit, Ontario. Scolecodonts are common throughout the member and may be seen on the surface of the ripple-marked layer. The following species were found:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites kopfi Eller
Œnonites parvidentatus Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Ildraites horridus Eller
Leadicites variedentatus Eller
Arabellites rectidens Eller
Paleononites parallelus sp. nov.
Staurocephalites externus sp. nov.

About 100 pounds of material from this locality was treated. The residue was mostly a fine mud and gray and white quartz sand. Some bornite, chalcopyrite, and a few microscopic silicified crinoid columnals passed through a 60-mesh sieve and were caught on 150-mesh.

INGLEWOOD, ONTARIO

Thin-bedded Whirlpool sandstone is being quarried here for flags and building stone. Annelid jaws were found on the surface of the slumping Manitoulin beds that are being removed as overburden. Sandy, ripple-marked layers are present and jaws and trails were noted on the surfaces. Specimens were quite plentiful, but only the following species were recorded:

Lumbriconereites hibbardii Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites kopfi Eller
Œnonites parvidentatus Eller
Œnonites lewistonensis Eller
Ildraites peramplus Eller
Leodicites variedentatus Eller

Besides silt and scolecodonts, residues contained many quartz grains, a small amount of graphite, a few silicified crinoid columnals, and grains of spheroidal chalcedony.

FORKS OF THE CREDIT, ONTARIO

In the gorge of the west branch of the Credit River, near the railroad station, about 25 to 30 feet of Manitoulin beds are well exposed in a line of old quarries. The lower 10 feet are thin-bedded, sandy, and contain shale partings; scolecodonts and other fossils are common. Ripple-marked layers are present and a few jaws were noted in them. In the next 6 feet a layer containing solution cavities filled with pink celestite is present. The upper beds are more massive, with some charty layers and greenish shale partings. The scolecodont fauna contains:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites levis Eller
Œnonites lewistonensis Eller
Œnonites triangulus Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Ildraites geminus Eller
Ildraites horridus Eller
Ildraites patulus Eller
Leodicites caleyi sp. nov.
Leodicitis variedentatus Eller
Arabellites rectidens Eller
Eunicites vertex Eller
Diopatraites fustis Eller

Samples were taken from most of the layers at this locality. They dissolved completely, leaving a residue of silt, white and iron-stained quartz grains, and some selenite, graphite, chalcopyrite, hematite, pyrite, and scolecodonts. An analysis by the Department of Mines, Ottawa, gives the calcium carbonate content as 47.39 per cent, and the magnesium carbonate as 35.72 per cent.

CATARACT, ONTARIO

About 25 feet of Manitoulin are exposed in the gorge of the Credit River at Cataract, Ontario, just below the hydro-electric plant. This is the type locality of the Cataract formation. Magnesian limestone layers reach 12 inches in thickness and are separated by thin partings of shale. Irregular zones of chert are present. Fossils are very common, but scolecodonts are not very plentiful. They include:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Œnonites kopfi Eller
Œnonites flexus Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Diopatraites fustis Eller

The residue from the magnesian limestone contains silt, scolecodonts, white and iron-stained quartz grains, microscopic silicified crinoid columnals and sponge spicules, pyrite and bornite. A fragment of a large *Lumbriconereites,* 4 mm. long, was found at this locality. The original must have been at least 7 mm. in length.

GLEN CROSS, ONTARIO

West of Glen Cross, the Manitoulin outcrops at a falls in the gorge of a tributary of Nottawasaga River. About 30 feet of thin-bedded crystalline magnesian limestone are exposed. Scolecodonts were noted on the surface of the rocks and the following forms were collected:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites triangulus Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Diopatraites fustis Eller

In addition to the silt, white and stained quartz grains, pyrite, and scolecodonts were common in the residue.

LAVENDER, ONTARIO

Near Lavender, Ontario, the Manitoulin forms a second escarpment below the Lockport dolomite. Large blocks of the Manitoulin and of the Whirlpool sandstone were found in the talus slope of the red Richmond beds. The Manitoulin magnesian limestone is crystalline and weathers a bright buff. Jaws were noted on some rocks and the following forms were found:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Staurocephalites externus sp. nov.
Diopatraites fustis Eller

A residue of silt, scolecodonts, white and iron-stained quartz grains, and pyrite remained after samples were treated with acid.

COLLINGWOOD, ONTARIO

Northwest of Collingwood, the Manitoulin dolomite forms a bold escarpment below the Lockport. The section measures 14 feet, 5 inches, and rests on gray shale of the Queenston. The gray dolomite, weathering to a light gray or buff, is thin-bedded though least so at the base. The strata are mostly unevenly bedded and break away from the escarpment in large blocks. Typical Manitoulin fossils were found at this locality, but scolecodonts were not noticed on the surface of any of the material collected. Residue from the

dolomite contained a few specimens and species, but less than at any other locality studied. The following species were found:

Lumbriconereites scrobiculus sp. nov.
Œnonites kopfi Eller
Œnonites marginatus sp. nov.
Staurocephalites externus sp. nov.

The residue from the dissolved dolomite consisted mostly of iron-stained quartz grains, some pyrite, silicified crinoid columnals, and a few ostracods.

VANDERLEUR, ONTARIO

At a falls on a tributary of the Beaver River near Vanderleur, Ontario, the Manitoulin rests directly on red and green shales on the Queenston. The lower 3 feet of the Manitoulin are massive and quite sandy; scolecodonts were observed on surfaces of slabs. The upper layers are thinner and more crystalline. The scolecodont fauna contains:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites marginatus sp. nov.
Ildraites geminus Eller
Leodicites variedentatus Eller
Staurocephalites externus sp. nov.

The residue from the lower, heavier layers consisted of silt, scolecodonts, iron-stained quartz grains, and pyrite. In addition to these, the upper layers contained microscopic silicified crinoid columnals, and graphite.

ORANGEVILLE, ONTARIO

Two small abandoned quarries just north of Orangeville were opened to secure a thin section of the Whirlpool sandstone. About 6 feet of heavy layers of the Manitoulin member occur in the quarries and have weathered out in large blocks. A small stream runs through both quarries and thin layers of Manitoulin outcrop along the banks above the quarries. Fossils are well-preserved and include the following scolecodonts:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites triangulus Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Idraites geminus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Staurocephalites pyramis sp. nov.
Staurocephalites externus sp. nov.
Diopatraites fustis Eller

The material dissolved and left a residue of fine silt, white and gray quartz grains, some pyrite, spheroidal chalcedony, sponge spicules, microscopic crinoid columnals, and scolecodonts.

OWEN SOUND, ONTARIO

The Manitoulin is well exposed in several large quarries within the city limits of Owen Sound. About 15 feet of magnesium limestone appear in the quarries but, from additional outcrops along the escarpment, it is inferred that the beds reach some 30 feet in thickness. They are thin-bedded at the top but more massive and sandy basally. Several zones of chert are present. Well-preserved fossils are common, including the following scolecodonts:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites marginatus sp. nov.
Œnonites parvidentatus Eller
Ildraites peramplus Eller
Ildraites geminus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Staurocephalites pyramis sp. nov.
Staurocephalites externus sp. nov.

An analysis by the Department of Mines, Ottawa, gives the percentage of magnesium carbonate as 39.11 and of calcium carbonate as 50.62. Samples taken from various levels of the outcrop dissolved rapidly and completely in acid. Buff-weathered granular specimens or those that had the appearance of being dolomitic were especially tested. Besides scolecodonts, the residues consisted of buff silt, white, and iron-stained quartz grains, a small amount of pyrite and graphite, and a few microscopic, silicified crinoid columnals.

KEMBLE, ONTARIO

The Manitoulin forms a prominent escarpment along the west side of Owen Sound about a mile east of Kemble, Ontario. At this locality the beds are more than 40 feet thick, but are not as massive as in the quarries at Owen Sound. Some of the upper beds have probably been removed by glaciation and the upper surface is well polished and striated. Scolecodonts are plentiful and include these species:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites lewistonensis Eller
Ildraites geminus Eller
Ildraites peramplus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Staurocephalites pyramis sp. nov.

The residue consisted of white and iron-stained quartz grains, mica, chalcopyrite, selenite, pyrite, scolecodonts, and large quantities of microscopic silicified crinoid columnals.

WIARTON, ONTARIO

About 4 miles northeast of Wiarton on the south side of the Colpay Bay, near Oxenden, the Manitoulin outcrops at water level along the lake shore. Northeastward along the escarpment, about 30 feet of beds are exposed. Some layers are quite thick. Scolecodonts were found in a layer about half-way up the escarpment, but samples were taken throughout the member. The scolecodont fauna includes:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Ildraites geminus Eller
Leidicites variedentatus Eller
Staurocephalites pyramis sp. nov.
Staurocephalites externus sp. nov.

A residue of silt, iron-stained quartz grains, microscopic crinoid columnals, and scolecodonts resulted from the treatment of this material with hydrochloric acid.

Sections on Manitoulin Island, Ontario

SOUTH BAY

Thin beds of Manitoulin dolomite outcrop along the lake shore. Only a

few feet of strata are exposed, but most of the layers are quite fossiliferous. A few jaws were seen on the surface, and the beds yielded the following species:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Ildraites geminus Eller
Arabellites rectidens Eller

Besides silt and scolecodonts, the residue contained little except white and iron-stained quartz grains.

MANITOWANING, MANITOULIN ISLAND

A small section of Manitoulin is exposed by a roadcut about 2.5 miles northwest of Manitowaning. The beds here are thin, weathering from gray to buff. A large number of paws were found, representing:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Ildraites horridus Eller
Leodicites variedentatus Eller
Leodicites caleyi sp. nov.
Arabellites rectidens Eller
Paleononites parallelus sp. nov.
Staurocephalites externus sp. nov.
Eunicites (?) *index* sp. nov.

Several pounds of material were dissolved. The residue consisted of buff-colored silt, scolecodonts, and white and iron-stained quartz grains.

SHEGUIANDAH TOWNSHIP, MANITOULIN ISLAND

The lower part of the Manitoulin is exposed about 2.5 miles south of Green Bay and 1.5 miles northwest of Bass Creek in Sheguiandah Township. Both thick and thin layers are present; they weather to buff. Scolecodonts and other fossils are plentiful, the former including:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Ildraites geminus Eller
Leodicites variedentatus Eller
Staurocephalus externus sp. nov.

Buff-colored silt, white quartz grains, a small amount of graphite, and scoleocodonts were present as residue after the rock from this locality was dissolved.

GREEN BAY, MANITOULIN ISLAND

A bioherm about 50 feet thick lies on the Gore Bay-Manitowaning road east of Green Bay. Just south of the bioherm, the Manitoulin thins out and is much weathered. Fossils of many types are abundant and scolecodonts are plentiful. Jaws were also found to be present in the bioherm. The following species were collected:

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites exactus Eller
Œnonites kopfi Eller
Œnonites marginatus sp. nov.
Ildraites peramplus Eller
Ildraites geminus Eller
Leodicites variedentatus Eller
Arabellites rectidens Eller
Eunicites (?) *index* sp. nov.
Dipatraites fustis Eller

In addition to scolecodonts, the residue contained white and iron-stained quartz grains, graphite, and buff-colored silt.

BIDWELL, MANITOLIN ISLAND

Along the highway, west of Green Bay, Town of Bidwell, the "hydro company" in 1940 blasted 6 to 8 foot holes for power line poles. Both heavy and thin layers were noted in the blue-gray magnesian limestone taken from these holes; rock was beginning to weather buff one year after excavation. The following scolecodonts were identified:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites lewistonensis Eller
Ildraites geminus Eller
Ildraites peramplus Eller

The residue consisted of scolecodonts, buff silt, quartz grains, silicified crinoid columnals, and a small amount of pyrite.

KAGAWONG, MANITOULIN ISLAND

About 1.5 miles southwest of Kagawong, a small quarry has been opened where the Gore Bay road cuts the escarpment. The Manitoulin-Richmond contact is well exposed in this quarry. Directly on top of the calcareous Richmond lie a few inches of detrital argillaceous sandstone which reminds one of the Whirlpool, though its source may have been from the north. More than 20 feet of thick to thinly bedded Manitoulin dolomite, somewhat argillaceous, are present in the quarry and along the road. It weathers brown to light buff and gray, with an occasional blue mottling.

Scolecodonts were found in most layers, but were specially common in the middle ones. Other typical Manitoulin forms were common in the section, but in the upper beds several additional elements are present. It is possible that some of the brachiopods, corals, and bryozoans may be new. The beds yielded the following scolecodonts:

Lumbriconereites hibbardi Eller
Lumbriconereites scrobiculus sp. nov.
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites marginatus sp. nov.
Ildraites geminus Eller
Leodicites variedentatus Eller

The residue contained buff-colored silt, scolecodonts, quartz grains, some of which were iron-stained, and microscopic crinoid columnals.

GORDON TOWNSHIP, MANITOULIN ISLAND

An undetermined thickness of Manitoulin outcrops along the hillside bordering the road leading to the bridge linking Manitoulin Island to Barrie Island. The lowermost strata are both heavy and thin-bedded and contain scolecodonts and other typical fossils. Above these are some thin-bedded, fine-grained layers containing a variety of fossils, including an *Orthorhynchula* which may be new. The uppermost beds are quite sandy and contain an abundant fauna. The scolecodont fauna includes:

DISTRIBUTION OF DIAGNOSTIC MANITOULIN SCOLECODONTS IN NEW YORK AND ONTARIO

Localities	*Lumbriconereites hibbardi* Eller	*Lumbriconereites scrobiculus* sp. nov.	*Nereidavus invisibilis* Eller	*Œnonites exactus* Eller	*Œnonites kopfi* Eller	*Œnonites marginatus* sp. nov.	*Ildraites peramplus* Eller	*Ildraites geminus* Eller	*Leodicites variedentatus* Eller	*Arabellites rectidens* Eller	*Staurocephalites pyramis* sp. nov.	*Staurocephalites externus* sp. nov.
Pekin, N. Y.	C	C	A		C		C	A	A	A	A	R
Niagara Gorge, N. Y.	A	R	A	A	A		A	A	A	A		
Stoney Creek, Ont.	A		A	R	A	A	R		C	R	R	R
Dundas, Ont.		R	R		C					C	R	
Glen Williams, Ont.	A	C	A	R	C	C	C		A	A		R
Inglewood, Ont.	C	R	A	R	C		R		R			
Forks of the Credit, Ont.	A	A	A		R	R	A	R	A	A		
Cataract, Ont.	C	A	A		C	R	C		R	A		
Orangeville, Ont.	A	A	A		C	R	C	R	C	C	R	R
Glen Cross, Ont.	A		A	R		R	A		R	R		
Lavender, Ont.	A	C	R		R	C						R
Collingwood, Ont.		R			R	R						R
Vanderleur, Ont.	A	A	A	R		A		C	R			R
Owen Sound, Ont.	C	A	A	R		R	R	R	A	R	R	A
Kemble, Ont.	A		A				C	R	R	R	R	
Wiarton, Ont.	A	C	A			R	C	C	C		R	C
South Bay, Manitoulin Is., Ont.	C		R		R			R		R		
Manitowaning, Manitoulin Is., Ont.	A	A	A		A	R	A		A	R		C
Sheguiandah, Manitoulin Is., Ont.	A		A			R	C	C	A			R
Green Bay, Manitoulin Is., Ont.	A		A	R	C	R	A	A	C	A		
Bidwell, Manitoulin Is., Ont.	A	C	C		R		R	R				
Kagawong, Manitoulin Is., Ont.	A	R	A		C	R		C	C			
Gordon Twp., Manitoulin Is., Ont.	A		A		C			C	C			

(Explanation of letters—A, abundant; C, common; R, rare)

Lumbriconereites hibbardi Eller
Nereidavus invisibilis Eller
Œnonites kopfi Eller
Œnonites bidens Eller
Ildraites geminus Eller
Leodicites variedentatus Eller

The residue contained white and iron-stained quartz grains, spherical quartz, pyrite, and scolecodonts.

Scolecodont Fauna

General Statement

The accompanying table lists the diagnostic scolecodonts occurring at selected localities and their relative abundance in the Manitoulin dolomite. Very rare forms were not included. Many new species were found during the examination of residues, but since they were only represented by a few specimens, descriptions were not undertaken. Two species, *Lumbriconereites hibbardi* and *Nereidavus invisibilis*, were found to be very abundant at most localities. This has been the case in other studies, in which the individuals of one or two forms were found to outnumber all other species (Eller, 1934, 1938, 1940, 1941). Annelids must have been an important factor in the fauna during Manitoulin times, for at most localities their jaws seem as plentiful as any other fossils. At some exposures and in some layers, scolecodonts were the only fossils found.

The species listed in the descriptions of the sections and in the table prove that scolecodonts do have an extensive geographic distribution. Very few observations could be made on their vertical range, since they have been studied only from a few scattered horizons and localities. Three scolecodont species from the Erindale member of the Meaford formation of the Upper Ordovician, Eller (1942) occur in the Manitoulin.

The maxillae and mandibles included among scolecodonts are very like those of modern polychaetes. If the jaw apparatus is indicative of morphology in general, this group has probably evolved little since Paleozoic times.

Modern polychaetes have world-wide distribution. They are usually found in shallow and even intertidal areas, but they also occupy deeper zones of the sea. They seem to prefer a bottom composed of muddy material containing organic matter, which both provides a stratum for burrows and a source of food. Scolecodonts were found in greater numbers, both of specimens and of species, in the Niagara area or in the near-shore deposits of detrital and ripple-marked material. Northwestward, as the beds become increasingly calcareous and dolomitic, scolecodonts are reduced in both abundance and variety. At the Forks of the Credit, Ontario, the beds are slightly impure and the scolecodont fauna noticeably increases. On Manitoulin Island a number of bioherms are present and at their edges the number of scolecodonts increases to a marked degree. In the South Seas, polychaetes are very common in the vicinity of coral reefs. By analogy with the distribution and habitats of modern polychaetes, it is suggested that the Manitoulin sea was a warm, shallow, well-aerated body of water with a relatively low salinity.

| | | |

Systematic Descriptions

Genus LUMBRICONEREITES Ehlers, 1868

Lumbriconereites scrobiculus Eller, sp. nov.

Plate 4, Figs. 1-6.

Description.—The jaw is narrow and elongate with 12 to 18 sharp, conical denticles which extend along the inner margin nearly to the posterior end. At the anterior end the denticles often point in a forward direction, then become perpendicular to the margin, and finally point backward. The fang is large and hooked, and lies in a plane parallel or perpendicular to the inner side. It appears to be a continuation of the outer margin. The second denticle is large and is followed by several small teeth. At the central part of the margin the denticles are rather large, but they decrease in size toward the posterior end. A narrow, deep muscle fossa extends almost the full length of the jaw. The inner margin of the fossa is thickened and well rounded; it extends beyond the anterior end in the form of a ridge. The area between the margin of the fossa and the denticles is deeply concave. The outer margin is irregular, thin, and often broken. The under side is concave, while the upper side is convex. Measurements of the specimens range from 0.2 mm. to 1.62 mm. in length.

Relationships.—This species is common at most of the localities. The specimens are often variable in some details, especially in the arrangement of the denticles and the outline of the outer margin. *Lumbriconereites cooperi* Eller (1938) is very similar to this form, but *Lumbriconereites scrobiculus* is not as wide and the area between the margin of its fossa and the denticles is much deeper. The margin of the fossa extends anteriorly to it in the form of a ridge which has not been observed in any other species.

Genus STAUROCEPHALITES Hinde, 1879

Staurocephalites pyramis Eller, sp. nov.

Description.—The jaw is large, long, wide and flattened, with an acute anterior extremity and a well-rounded posterior end. At about one-third the distance from the anterior end, a series of 15 to 16 sharp, conical, backwardly directed denticles extends to the posterior extremity. The first denticle or fang is very large, triangular and flattened. It begins near the anterior end and extends nearly to the outer margin on the under side of the jaw. The remaining denticles increase slightly in size to the center of the jaw and decrease rapidly to the posterior end. A long, wide fossa extends the full length of the jaw. The margin of the fossa is thin and usually broken. The under surface is slightly concave or flattened; the upper side is convex. Specimens measure 0.75 mm. to 1.29 mm. in length.

Relationships.—This species is very closely related to *Staurocephalites cuspis* Eller (1942). It is not as long, the width is much greater, the fossa is wider, and it has fewer denticles. *Staurocephalites pyramis* is generally similar to *S. niagarensis* Hinde (1879), but Hinde's figure and description lack sufficient detail for close comparison.

Plate 4, Figs. 22, 23

Staurocephalites externus Eller, sp. nov.

Plate 4, Figs. 24-26

Description.—The jaw is narrowly elongate, measuring 0.64 mm to 0.99 mm. in length. A series of 15 to 24 sharp, conical backwardly directed denticles extends along the inner margin for its full length. On the larger specimens the posterior denticles are often minute. The row of denticles is straight except at the anterior end where it curves outward toward the outer margin. The first denticle is usually larger, especially at the base, and often it is at a slightly acute angle with the under surface. A fossa, wide at the anterior end but narrowing to the posterior end, occupies the entire upper side of the jaw. The margin of the fossa is usually broken but even in fragmentary specimens it is possible to determine that it is thickened and rounded. The area near the margins is concave or flattened.

Relationships.—Stauffer (1933) described several species *Staurocephalites acutidentatus, S. dentatus,* and possibly *Lumbriconereites perfectus,* which have a general similarity to *S. externus.*

Genus LEODICITES Eller, 1940

Leodicites caleyi Eller, sp. nov.

Plate 4, Figs. 17, 21

Description.—The jaw is small subtriangular and often variable in its details. A series of 6 or 7 sharp, pointed, conical denticles extends the full length of the inner margin. The first denticle is small or may be missing entirely. The second denticle is very large and usually quite straight. The remaining denticles are small and may be directed backward or perpendicular to the margin. The anterior margin may be nearly straight or may curve slightly upward or downward. It terminates in a long, narrow, pointed shank. The outer margin is slightly incurved. A deep, narrow fossa occupies the upper side, including the shank. The margin of the fossa is slightly thickened and rounded, especially on the upper side. The under side is large and convex, while the upper is small and slightly concave. Specimens measure .24 mm. to .32 mm. in length.

Relationships.—*Leodicites caleyi* is not very similar to any other form, though several species resemble it when viewed from certain sides. *L. acclivis* Eller (1942) has the same general characteristics, but there is no detailed resemblance.

Genus PALOENONITES, Eller, 1942

Paloenonites parallelus Eller, sp. nov.

Plate 4, Figs. 15, 16

Description.—The width of the jaw is greater than the length of the outer margin. The outline of the jaw is subrectangular. On the inner margin a series of 9 to 14 small, blunt, backwardly directed denticles extends to the posterior end. The first denticle is larger than the one following; the others decrease

in size to the posterior extremity. On some specimens the denticles are practically worn away. The anterior, posterior, and outer margins are straight or slightly incurved and almost form right angles with each other. The fossa is narrow and extends the full length of the jaw. The margin of the fossa is wide, heavy and well rounded. The under surface of the jaw is convex, but flattened at the outer margin. The upper surface is concave and flattened. Measurements of the specimens range from 0.29 mm. to 0.62 mm.

Relationships.—This form is wider than any other member of the genus. Except for its width, it is similar to *P. accuratus* Eller (1942). *Arabellites erectus* Stauffer (1933) is somewhat similar to *P. parallelus*, but differs in the width of its posterior and size of its denticles. Hinde (1879) described a species, *Arabellites scutellatus* Hinde (1879) from the vicinity of Toronto which has the angularity of *P. parallelus*, but differs in the width of the jaw and in the shape of the posterior end.

Genus OENONITES Hinde, 1879

Oenonites marginatus Eller, sp. nov.

Plate 4, Figs. 11-14

Description.—The jaw is small, narrow, and tapers from a rounded anterior end to an acute posterior extremity. A series of 12 to 15 sharp, conical, backwardly directed denticles, of medium size, extends the full length of the jaw. Denticles at the anterior end of the jaw are rather uniform in size, decreasing only slightly posteriorly. At the posterior end of the jaw the denticles are much reduced and may become minute. The inner margin is almost straight, while the outer margin is usually incurved at about the midlength. A large fossa which occupies the upper surface is narrow a short distance from the anterior end. The margin of the fossa is thick and well rounded. The lower surface is generally convex, but adjacent to the margins of the fossa it is concave or flattened, this concave area emphasizing the margins of the fossa. Specimens are 0.43 mm. to 0.75 mm. long.

Relationships.—*Œnonites excavatus* Eller (1941) somewhat resembles *Œ. marginatus* but differs in the shape of the fossa, distribution of the denticles, and the character of the area near the margin of the fossa.

Genus EUNICITES, Ehlers, 1868

Eunicites (?) index Eller, sp. nov.

Plate 4, Figs. 7-10

Description.—The jaw is small and rectangular in outline, and is wider than long. Near the denticles the outer margin extends anteriorly in the form of a slightly hooked flange which at first appears to be a denticle, its position being such that it may have served in that capacity. A series of four denticles extends along the inner margin. The first is very large, straight, sharply pointed and conical. The remaining three are similar in shape but very much smaller. A rectangular fossa occupies the anterior upper surface of the jaw. The margin of the fossa, when not broken away, is thickened and rounded. The under side

is slightly convex or flattened. Three jaws measured 0.21, 0.24, and 0.27 mm. in length and 0.38, 0.40, and 0.38 mm. in width.

Relationships.—Eunicites (?) *index* is not very closely related to any other species. It might be placed in *Leodicites* because of the presence of the flange, but it does not have the outline and length of that genus.

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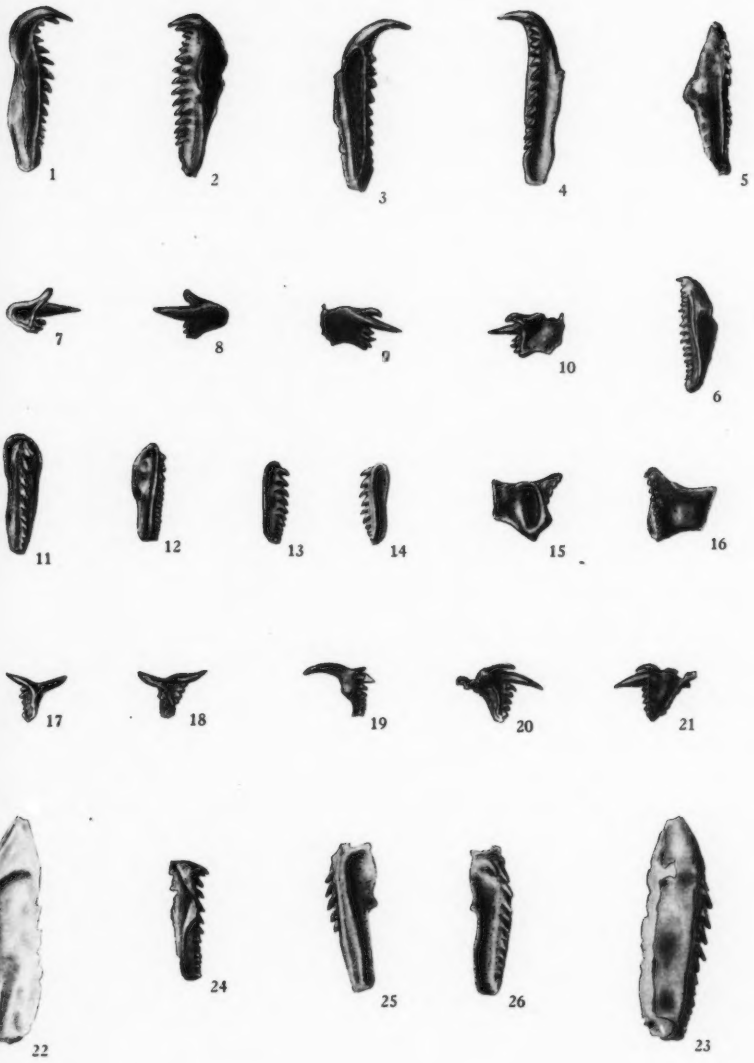
PLATE 4

Scolecodonts from the Manitoulin of Ontario

PLATE 4.—Figures magnified about 30 times. Numbers in parentheses at the right indicate the Carnegie Museum catalogue numbers of the respective type specimens. 1-2. *Lumbriconereites scrobiculus* Eller, sp. nov. Maxilla I, right jaw (24344). Side view and upper side. North of Orangeville, Ontario. 3-4. *Lumbriconereites scrobiculus* Eller sp. nov. Maxilla I, left jaw (24355). Upper and lower sides. Lavender, Ontario. 5. *Lumbriconereites scrobiculus* Eller, sp. nov. Maxilla I, right jaw, under side, (24345). North of Orangeville, Ontario. 6. *Lumbriconereites scrobiculus* Eller, sp. nov. Maxilla I, right jaw, upper side (24351). Forks of the Credit, Ontario. 7-8. *Eunicites* (?) *index Eller*, sp. nov. Maxilla III (?), left jaw (24262). Upper and under sides. Manitowaning, Manitoulin Island, Ontario. 9-10. *Eunicites* (?), *index Eller*, sp. nov. Maxilla III (?), right jaw (24265). Under and upper sides. Green Bay, Manitoulin Island, Ontario. 11. *Œnonites marginatus* Eller, sp. nov. Maxilla II, right jaw, under side (24300). Canning Falls, Glen Cross, Ontario. 12. *Œnonites marginatus* Eller, sp. nov. Maxilla II, left jaw, side view (24301). Lavender, Ontario. 13-14. *Œnonites marginatus* Eller, sp. nov. Maxilla II, right jaw (24302). Side view and upper side. Lavender, Ontario. 15-16. *Paloenonites jarallelus* Eller, sp. nov. Maxilla II, left jaw (24266). Upper and under sides. Norton Quarry, Glen Williams, Ontario. 17-18. *Leodicites caleyi* Eller, sp. nov. Maxilla II, right jaw (24272). Upper and under sides. Forks of the Credit, Ontario. 19. *Leodicites caleyi* Eller, sp. nov. Maxilla II, right jaw, under side (24273). Manitowaning, Manitoulin Island, Ontario. 20-21. *Leodicites caleyi* Eller, sp. nov. Maxilla II, left jaw (24274). Upper and under sides. Manitowaning, Manitoulin Island, Ontario. 22-23. *Staurocephalites pyramis* Eller, sp. nov. Maxilla II, left jaw (24275). Under and upper sides. East of Kemble, Ontario. 24. *Staurocephalites externus* Eller, sp. nov. Maxilla II, right jaw, side view (24285). North of Orangeville, Ontario. 25-26. *Staurocephalites externus* Eller, sp. nov. Maxilla II, right jaw (24295). Upper and under sides. Colpoy Bay, Wiarton, Ontario.

AMER. MIDL. NATUR. 32(3), Nov. 1944, facing p. 754

PLATE 4



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Atractites and Related Coleoid Cephalopods

Rousseau H. Flower

Atractites Guembel has been widely employed as a receptacle for early Mesozoic belemnoids with smooth rostra, and has been regarded as one of the most ancient and most primitive of the Coleoidea. However, a survey of the literature showed that authors had not agreed very closely on the morphological features which are to be attributed to the genus. Indeed, three radically different concepts have been presented by von Mojsisovics (1902), Hyatt and Smith (1905), and Dunbar (1924). The present work is an investigation of the nature of *Atractites* and some of the species which have been assigned to it. Unfortunately, *Atractites alpinus*, the genotype, is so inadequately known that its identity is very dubious. While *Atractites* is a valid genus, it is one to which no other species can be assigned with certainty.

Inspection of the more adequately known species formerly included in *Atractites* reveals one large group of forms with essentially the features which von Mojsisovics and most subsequent European investigations had regarded as diagnostic of the genus. For these species the new name *Ausseites* is proposed. *Atractites philippi* Hyatt and Smith is markedly different. Indeed, it appears to be closely allied to *Diploconus*, but not to *Ausseites*. The genus *Metabelemnites* is erected for this species. Dunbar's (1924) concept of *Atractites* differs from the other two, but no species has yet been demonstrated to possess the shell features which he postulates.

The writer wishes to express his thanks to Dr. J. B. Reeside for suggestions and discussion in relation to the problem of *Atractites* and its elusive genotype. Belemnoid material bearing upon the problem was made available by the U. S. National Museum, the Academy of Natural Sciences of Philadelphia and the University of Cincinnati Museum. The writer is deeply indebted to the Academy of Natural Sciences of Philadelphia for the use of its remarkably complete library, and wishes to express his gratitude to Dr. C. M. B. Cadwalader and to the members of the library staff.

ATRACTITES Guembel

Genotype: *Atractites alpinus* Guembel

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———Diener, 1915, Fossilium Catalogus, I. Animalia, Part 8, Cephalopoda Triadica, p. 17.
———Von Bülow-Trummer, 1920, Fossilium Catalogus, I. Animalia, Part 11, Cephalopoda Dibranchiata, p. 64.
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This generic name has been widely applied to early Mesozoic dibranchiate cephalopods, von Bülow-Trummer listing fifty-eight species. Most subsequent authors have followed the morphological concepts laid down by Mojsisovics (1902) in his revision of the genus. Yet so much uncertainty surrounds the identity of the genotype, that no other species can be placed in the genus with certainty. To demonstrate this, the history of the treatment of the genus is briefly outlined here.

Guembel (1861, p. 475-6) described the genus and its type species as follows:

Atractites alpinus, ein Problematicum, das in sehr zahlreichen Exemplaren vorliegt und seiner äunssern Form nach am ehesten an Belemniten erinnert. Langgezogene, spindelförmige Körper, sich gegen beide Enden verjüngend, besitzen bei 125 Linien Länge am dicksten Theile 11 Linien Durchmesser und bestehen aus einer Schale, welche aus concentrisch über einander liegenden, glatten, radialfasrigen Schichten zusammengesetzt ist; das Innere des von dieser Schale umschlossenen Raumes ist von krystallischem Kalkspath oder Hornstein ausgefüllt und zeigt in Centrum eine der Scheitellinie der Belemniten ähnliche, kleine Röhre, von der mehrere (in der Regel zwei), scheidenartige Wände gegen die Schale radial verlaufen und den innern Raum in zwei Hälften theilen. Weder von Kammern noch von Alveolen zeigt sich ein spur. Rinnenartige Einschnitte, in der Mitte am tiefsten, gegen die beiden Enden sich verlierend, kommen nicht bei allen Exemplaren vor, das ende ist meist rasch zugespitzt und ohne Rinne. Die Schalenoberfläche ist glatt, nur gegen die Enden zuweilen der Länge nach gestreift. An einem Ememplare zeigt sich in der Mitte eine säulenartige Achse, an der zahlreiche radiale Lamellenansätze sichtbar sind.

This description is preceded by that of another species which is quoted here inasmuch as it must be considered in discussing the identity of *Atractites alpinus*:

Orthoceras liassicus Guembel, spec. innom. Hau. [Hauer]. An mehr als 50 Exemplaren (Bruchstücken) mit zum Theil sehr gut erhaltener Schale zeigt sich die Oberfläche durchaus ungestreift, glatt, der Sipho liegt seitlich wie beiv. Hauer's *Orthoceras alveolare* Quenstedt, doch beruht eine Trennung beider Arten in der Art der Abnahme des Durchmessers, welche bei unserer Art 16% der Länge, bei *O. alveolare* nur 11% beträgt.

It is evident that *Orthoceras liassicus* is a phragmocone such as might belong to a primitive belemnite rather than to a nautiloid. It is equally evident that *Atractites alpinus* was based upon a collection of rostra which fail to show

the alveolus or phragmocone, and which are narrowed at each end, presenting a type of preservation which is now known to occur in a variety of belemnites from the Triassic to the Cretaceous. Such fragments cannot be definitely identified with more complete shells except by inference based upon stratigraphic and regional association. Phillips (1865) states that such shells as are fusiform developed from "decay" of the laminae in the peripheral region of the shell, and remarks that such species formed the basis of the genus *Actinocamax* Miller. We are not here concerned with the problems surrounding *Actinocamax,* which has subsequently been recognized sometimes as a subgenus of *Belemnites* (Hyatt, 1900) and again as a genus (Von Bülow-Trummer, 1920), but only with the fact that fusiform guards are not natural but are the result of modification of an originally complete and normal belemnite shell probably in part by solution and in part by abrasion. A species based upon such material is most inadequate as the basis for a genus. In this particular case the difficulty is made even greater because the species was not illustrated. It is quite possible that phragmocones belonging to this same species may have been known under another name. Further, it is even possible that the peculiarly altered guards which comprise *Atractites alpinus* may have represented the results of similar physical conditions acting upon the dead shells of several associated species.

Von Mojsisovics (1871) rejected *Atractites,* regarding it as a synonym of *Aulacoceras* von Hauer, stating that *Aulacoceras* was based upon the phragmocone and *Atractites* upon the rostrum of the same type of shell. This conclusion is justified by Guembel's description quoted above, and may be regarded as true with the reservation that von Mojsisovics is here employing *Aulacoceras* in the sense in which the family Aulacoceratidae was subsequently employed, embracing even the genus *Xiphoteuthis* Huxley. Further, von Mojsisovics (1871, p. 55, pl. 4, fig. 4-7,) includes in *Aulacoceras, Orthoceras liasicus* Frass, sp., and lists among its synonyms *Atractites alpinus.* If the two species are the same, the older name *liasicus* should take precedence, and that species would therefore become the type of *Atractites.* However, the acceptance of this conclusion involves several exceedingly dubious premises. First, there is some doubt as to what *Orthoceratites liasicus* v. Fraas, 1847, really is. Many authors, among them Guembel, (1861), Deiner (1915) and von Bülow-Trummer (1920) have expressed doubt as to the identity of the form popularly attributed to von Fraas' species with the original. Further, the fragmentary nature of the original material of *Atractites alpinus* Guembel prevents its positive identification either as a valid species in itself or as the synonym of a previously described species. Further, in view of the fragmentary condition of the original material of *Atractites liasicus* Guembel, its positive identification either as a recognizable species in itself or as a synonym of a previously described species is a matter which it would be most difficult to prove. It would require first of all a restudy of Guembel's original material. Even then, identity could be established with absolute certainty only by the discovery of a relatively complete shell combining the phragmocone recognizable as *Orthoceras liasicum* with a guard recognizable as *Atractites alpinus.* Occurrence of the two species in the same horizon indicated by Guembel in his faunal lists, increases the probability of their identity, but is far from being proof. There is no indica-

tion that von Mojsisovics or any subsequent author has restudied Guembel's material. No relatively complete specimen has been figured either as *A. alpinus* or *A. liasicus*. Therefore it seems necessary to reject von Mojsisovics' conclusion concerning the identity of these forms as unproved.

Atractites alpinus is clearly the genotype of *Atractites*. It is the only species included in the genus at the time of its original description, which automatically makes it the genotype by monotypy. Moreover, the definition of the genus and the type species comprise a single unit and are inseparable. But, since *A. alpinus* is based upon such fragmentary material that its true morphological characters are unknown, and since the material does not reveal the true nature of *Atractites*, no other species can be assigned to the genus with certainty.

The concept of *Atractites* has, however, persisted, and to it have been attributed characters not shown by the type species. The first to recognize the genus as valid subsequent to Guembel, was von Mojsisovics (1882) who differentiated it from *Aulacoceras* on the basis of the smooth exterior of the rostrum, a distinction accepted by all subsequent authors. No genotype is mentioned by von Mojsisovics. Zittel (1885) presented a description which in addition to following von Mojsisovics' distinction of the genus from *Aulacoceras*, calls attention for the first time to asymptodes on the conotheca. He lists two species, *A. alveolaris* (Quensted) and *A. Ausseanus* (v. Mojs.), notes that the genus was first noted from isolated fragments from the Lias of Kammerkahr, and points out that it may be differentiated from *Orthoceras* by the marginal siphuncle and the striation of the dorsum, and from *Aulacoceras* by the smooth tip of the rostrum. Von Hauer (1887) recognized the genus as defined by von Mojsisovics, but expressed doubt as to whether *Atractites* might not be the same as "some other forms." Unfortunately he does not state what other forms he had in mind. Hyatt's (1900) definition is only an abbreviated translation of Zittel's description. Von Mojsisovics, (1902) presented a redescription of the genus, distinguishing it by its smooth rostrum from *Aulacoceras, Asteroconites* and *Dictyoconites*. No mention is made of either *A. alpinus* or *A. liasicus*.

Hyatt and Smith (1905, p. 204) present a description of *Atractites* which does not emphasize the surface features of the guard, but stresses the long phragmocone and short guard, features not shown by any European species:

> The genus *Atractites* as restricted by Mojsisovics comprises belemnoid forms with long phragmocone and short guard. The phragmocone is chambered, long and slender, has simple concave septa, marginal siphuncle, backward pointing siphonal collars, and a calcareous protoconch. The guard is the calcareous sheath that surrounds the phragmocone; in the *Belemnites* it makes up the greater part of the shell, but in *Atractites* it is little longer than the chambered part and has neiher ridges nor furrows.

The shortness of the guard is a feature not previously noted. Indeed, many of the species placed in *Atractites*, including *A. liasicus* as figured (as *Aulacoceras*) by Branco (1880) show guards which approach and sometimes intergrade with the guards of *"Belemnites"* insofar as size is concerned. Indeed, the description seems to be largely colored by the species described in the same work, *Atractites philippii*, the short guard of which is unlike that of previously figured European *Atractites*. Again no genotype is mentioned. Other descrip-

tions cited under the genus are confined to a few remarks prefacing the description of new species.

Diener (1915) presents the first mention of a genotype since that implied in Guembel's original description. Without mention of *A. alpinus*, or *Orthoceratites liasicus*, he cites *Atractites alveolaris* Quensted, sp. This is apparently intended to be the designation of this species as a genolectotype. A possible alternate hypothesis, that Diener regards both *A. alpinus* and *A. liasicus* as synonyms of Quensted's older species, is rejected inasmuch as these named do not appear among the citations under *alveolaris*. Von Bülow-Trummer (1920) follows Diener in regarding *alveolaris* as the type of *Atractites*, but lists as a distinct species *Atractites liasicus* Fraas, sp., including under the citations of this form *Orthoceratites liasicus* Fraas, 1847, *Belemnites liasicus* Grewing, 1850, and *Belemnites clavatus* (pars) Quensted 1858, all with question. Definitely included are *Orthoceras liasicus* Guembel 1861, *Atractites alpinus* Guembel 1861, *Aulacoceras liasicum* von Mojsisovics 1871, and *Aulacoceras liasicus* Branco 1880.

The use of *Orthoceratites alveolaris* Quensted, sp. as the genotype of *Atractites* violates the rule of zoological nomenclature and cannot stand. Further, a new generic name is needed for a considerable group of species possessing the essential morphological features of *Atractites* as defined by Mojsisovics 1882 and most subsequent authors. *Atractites* however, based upon *A. alpinus*, is best regarded as a valid genus, but one which is so inadequately known on the basis of its genotype, that no other species should be placed in it.

Ausseites Flower, n. gen.

Genotype: *Atractites ausseanus* Mojsisovics

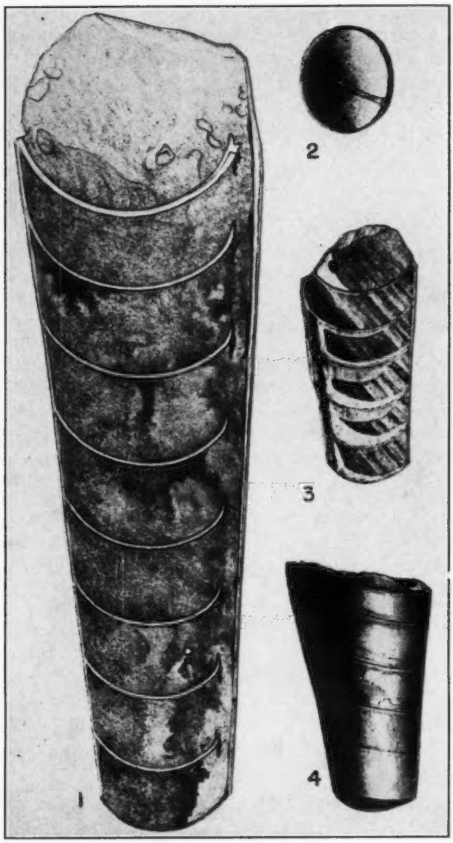
Plate 1.

This name is proposed for the group of species formerly included in *Atractites* by Mojsisovics and most subsequent European authors. The phragmocone is large, relatively slender, and more or less compressed in section. The septa are widely spaced in typical species. The siphuncle lies close to the venter. The septal necks are long, essentially orthochoanitic, though slightly divergent at their tips. The connecting ring, where preserved, completes the outline of the segments which are typically faintly fusiform, but which may also be essentially tubular. The conotheca was reported by Zittel (1885) to show normal conothecal striae with asymptodic zones bordering the dorsum. Pavlow (1913) and von Bulow-Trummer (1920) regard the "Tribe" Protobelemnitidae, to which *Ausseites* belongs, as possessing a very long dorsal and a shorter ventral proostracum.

The rostrum varies in shape, but is generally long, massive, and contracts gradually apicad, often exhibiting convex lateral profiled over the greater part of its length. Externally the rostrum is smooth, and *Ausseites* is differentiated from related genera, *Dictyoconites*, *Aulacoceras*, etc., largely on the basis of this feature. Internally, the rostrum shows the usual structure of radial aragonitic fibres and concentric growth lines.

Discussion.—The proposal of Ausseites fulfills the nomenclatorial need for a genus which can be used essentially as *Atractites* was employed by von

PLATE 1



Ausseites ausseanus (von Mojsisovics). 1. Vertical section of a large phragmocone. 2. Adoral view of a septum, showing cross section and position of siphuncle. 3. Vertical section from an early part of the phragmocone, showing a complete tubular siphuncle. 4. Lateral view of a portion of a phragmocone.

All specimens are from the *Trachyceras aonoides* beds of the Triassic, near Raschberg, Austrian Alps. After von Mojsisovics, about 3/5 natural size.

Mojsisovics (1902) and most subsequent European students of the belemnoids. A survey of its species shows however that the transfer of all species currently assigned to *Atractites* to *Ausseites* would be definitely premature. A large number of the species have been established upon fragmentary material. Even in the best of specimens the proostracum is almost uniformly missing, and the characters of the proostracum are inferred by a study of the conothecal striae. However, some species have been assigned to the genus which are known only from portions of the rostra. In the opinion of the writer, the position of these forms is highly uncertain.

Atractites was originally placed in the Belemnitidae (Zittel, 1885, Hyatt, 1900). However, subsequent authors have recognized the family Aulacoceratidae, containing the following genera:

Aulacoceras von Hauer.—Rostrum with about 40 strong longitudinal ribs. Angle of phragmocone 5-12 degrees. Cross section more or less rounded. In addition, Aulacoceras is known to have very widely spaced septa, a long relatively slender but faintly nummuloidal siphuncle, and a relatively smooth conotheca.

Asteroconites Teller.—This is recognized as a genus by Mojsisovics, but as a subgenus of Aulacoceras by von Bulow-Trummer (1920) and Naef (1922). It differs from typical Aulacoceras in having fine ribs on the conotheca. Preservation differences may account for its apparent distinction.

Dictyoconites von Mojsisovics.—This is characterized by the development of weaker ribs than those of *Aulacoceras,* though there is admittedly great variation in both their number and strength among the various species. The surface of the rostrum shows transverse markings simulating the conothecal striae, which combine with the fine longitudinal markings to produce a cancellate surface.

Ausseites Flower, n. gen.—This replaces *Atractites* as a genus of the Aulacoceratidae characterized by a rostrum which is externally smooth. It is known to have conothecal striae (Zittel, 1885). The phragmocone is typically similar to that of *Aulacoceras* in its proportions, but some species may attain a rapidly expanding conotheca and closely spaced septa which merge into those of higher belemnites not included in the Aulacoceratidae.

Calliconites Gemmelaro.—This is similar to *Ausseites,* but the phragmocone is set into the rostrum in an eccentric position. The phragmocone is slender, the septa strongly calcified. A prominent median ridge is reported on the venter of the phragmocone. The rostrum is more or less clavate, and bears two dorso-lateral and two ventro-lateral furrows.

Zugmontites, included in the family by von Bulow-Trummer, but not noted by Naef, (1922), is "bilaterally constructed; in even the early stages the phragmocone is slightly curved toward the ventral side."

Ziphoteuthis Huxley is treated as a subgenus of *Atractites* by von Bulow-Trummer, but is set aside in a family by itself the Xiphoteuthidae, by Naef (1922). The shell is extremely slender, having a long very narrow phragmo-

cone with very few septa, a long slender rostrum, and a long proostracum. This genus presents perplexities in the recognition of the proostracum and the rostrum as distinct structural entities. If, as is generally believed, the proostracum is a modified living chamber, it should be quite distinct from the rostrum which was added later. However in this genus, as in the sepioids, there is evidently a highly specialized condition, possibly involving integration of the two structures, which is so anomalous that the recognition of the Xiphoteuthidae seems desirable.

While it is quite simple to distinguish *Ausseites* from other Aulacoceratidae, it is much more difficult to distinguish it from belemnoids which have been placed elsewhere. While most recent students of the belemnites have been quite uniform in recognizing the *Aulacoceratidae,* and agree quite well as to its scope, except for the matter of *Xiphoteuthis,* definitions of the family by which it can be recognized are rare. In fact, it seems that in general the family has been recognized on the basis of the slender phragmocone and the widely spaced septa. Unfortunately, both criteria fail within species formerly assigned to *Atractites,* and inspection of the extant illustrations will show that while typical species show a marked contrast with other belemnites in the small apical angle and the widely spaced septa, there is an appreciable number of anomalous species which seem to bridge the gap. However, the suggestion does not seem to have been put forward that there might be a gradation through this genus from the Aulacoceratidae to the Belmnitidae. On the contrary, Pavlow (1913) and von Bulow Trummer (1920) accept a division of belemnoids into two "tribes." The first, the tribe Protobelemnitidae, contains only the Aulacoceratidae, and is characterized by a very long dorsal proostracum and a shorter ventral proostracum. On the other hand, all higher belemnites are united in the Eubelemnitidae characterized by having only a very long dorsal proostracum. If this is correct, the Aulacoceratidae can be readily distinguished from other belemnites if well enough preserved material is available. Further, this distinction will find its greatest usefulness in the separation of the smooth-shelled *Ausseites* from the "Eubelemnitidae" most of which have similarly smooth rostra.

Naef (1922) rejects this dichotomous division of the belemnites. However this is largely because his concept of the diversification of the belemnites requires more than two main stocks. He does regard the aulacoceroids as a development quite apart from that of the other belemnoids, though "*Atractites*" is regarded as the primitive radicle of the family and to it are traced practically all the other families of the belemnoides and sepioids. Unfortunately he does not discuss the validity of the proostracal features by which von Bulow-Trummer characterized the Aulacoceratidae. The writer has been unable to confirm the dorsal and ventral proostraca of the "Protobelemnitidae" either from figures or from specimens. Such material as has been examined, including a suite of European Triassic cephalopods, largely from the Muschelkalk, fails to show the conothecal markings at all, but the preservation is obviously unfavorable for the retention of such fine structures. While there is reason to believe that Pavlow and von Bulow-Trummer are correct in believing that the conothecal striae indicate a ventral proostracum in the Aulacoceratidae, it is to

be greatly feared that the striae have not been observed in enough cases to justify the use of this feature as a criterion of either a family or a "tribe" with the scope of the Aulacoceratidae. Further, it should be noted that while accepting this definition for the Aulacoceratidae, these authors have not only included within the family the anomalous *Xiphoteuthis* Huxley, which clearly lacks a ventral proostracum, but they have regarded this as a synonym of *Atractites*.

Ausseites is based upon *Atractites Ausseanus* von Mojsisovics, a species selected partly because the features of its phragmocone are well known, and partly because the original description is accompanied by illustrations which are adequate for the recognition of the species. Unfortunately the rostrum has not been illustrated. From von Mojsisovics' description this omission is due to the fact that the rostrum showed no features which were of any value in specific identification. Rostra have been figured for other species, which are similar to *A. ausseanus*. The use of these species as genotypes was avoided for nomenclatorial reasons. The original descriptions are not accompanied by figures, and in many cases there is reason to doubt whether the specimens which have been subsequently illustrated under these names are actually conspecific with the originals. *Atractites liassicum* (von Fraas) as represented by Mojsisovics (1871) and Branco (1880) is typical of *Ausseites*, and its rostrum has been illustrated. However, there is much uncertainty as to whether the species as figured is identical with the original of *Orthoceratites liassicus* of von Fraas. Similarly, *Atractites alveolaris* (Quensted) as generally identified, may not be identical with *Orthoceratites alveolaris* Quensted. Von Bulow-Trummer (1920) regards the identity of the specimens cited under these names as dubious. Under these circumstances, the use of these species as genotypes seems best avoided.

Metabelemnites Flower, n. gen.

Genotype: *Atractites philippii* Hyatt and Smith

Shell with a straight conical phragmocone, the septa moderately but not widely spaced, the sutures straight and transverse. The marginal siphuncle is not completely known, but its segments are tubular and not expanded within the camerae. The proostracum and conothecal striae are unknown. Clearly the conotheca projects orad of the phragmocone for a short distance, and appar ently projects orad of the edge of the rostrum, although here, as in other belemnoids, it is exceedingly difficult to determine the precise anterior boundary of the thin edge of the rostrum. The rostrum itself is conical and contracts very gradually from its adapical end to a point slightly posterior to the apex of the phragmocone. There it terminates in a blunt broadly rounded tip. The rostral surface fails to retain any characteristic ridges or furrows. It is calcareous, but fails to show the usual structure of radial fibres, exhibiting instead the amorphous structure suggestive of *Diploconus* and the Belemnoteuthidae.

Discussion—This genus differs from *Ausseites*, which embraces practically all other adequately known species formerly placed in *Atractites* in a number of very significant features. In *Ausseites* the phragmocone is typically long,

slender and pauciseptate. Here the cone expands more rapidly and is more closely septate. The siphuncle is tubular, and the segments apparently do not develop a slightly fusiform outline within the camerae. The rostrum is distinctive in its short and rounded apex. In *Ausseites* the rostrum is more elongate and typically extends far apicad of the apex of the phragmocone, as shown by the illustrations of Mojsisovics (1871) and Branco (1880), where it is sometimes slightly inflated near the apex before contracting to a slender point, and sometimes digitate. Further, in *Ausseites*, and indeed throughout the Aulacoceratidae the rostrum shows the usual belemnoid construction of radial fibres.

Conothecal striae are typically present in the Aulacoceratidae where they are reported as indicating the presence of a long proostracum on the dorsum and a very short one on the venter. (von Bulow-Trummer, 1920). In *Metabelemnites* the conothecal striae are not known. However, the continuation of the conotheca orad of the adoral septum does not indicate the presence of an unmodified living chamber. Such an adoral continuation of the conotheca orad of the last septum is well developed in many although not quite all of the belemnoid genera.

Closer to *Metabeliemnites* in the general form of the rostrum than any of the Aulacoceratidae are three genera, *Nanobelus, Diploconus* and *Belemnoteuthis. Nanobelus* is a belemnoid in which the rostrum is short, being sometimes reduced essentially to a short conical sheath surrounding the phragmocone. However its tip is pointed and not blunt, and internally it exhibits the usual pattern of radially arranged fibres. Further, the sides of the rostrum exhibit shallow lateral furrows, and the septa are either very thin or wanting.

Diploconus possesses a rostrum more similar to that of *Metabelemnites* in that the tip is blunt and rounded, and that it lacks the radial fibres, but this genus has a small, thin and fragile conchiolinous proostracum and the conotheca does not extend appreciably orad of the last septum, and is enclosed for its entire length by the rostrum.

The Belemnoteuthidae, using the term in the sense in which it was employed by Zittel (1885) and Hyatt (1900), are characterized by a calcification of the proostracum which may even show mother-of-pearl reflections in favorably preserved specimens, but the rostrum which is even more reduced in size than in any of the genera considered thus far, appears to have replaced the aragonitic structure by a conchiolinous one.

The relationship of these genera and families which have been compared with *Metabelemnites* have been given such different interpretations by different authors that it is hardly possible to accept any one system of classification. *Nannobelus* is regarded as a member of the Belemnitidae (Naef, 1922) and is included in the approximately equivalent "tribus" Eubelemnitidae of Pavlow and von Bulow-Trummer. There is little reason to doubt that this genus is closely allied to the typical belemnoids from which it differs largely in the reduced size of the rostrum.

Zittel (1885) and Hyatt (1900) placed *Diploconus* in the Belemnitidae, and included in the Belemnoteuthidae the genera *Acanthoteuthis, Phragmoteuthis* and *Belemnoteuthis*. Von Bulow-Trummer (1920) removed *Diploconus*

to the Belemnoteuthidae, a procedure which is suggested very strongly by the absence of radial fibre of aragonite in the rostrum. Naef (1922) however, erected the family Diploconidae for this and some allied genera, and regarded it as an end line of specialization quite distinct from the Belemnoteuthidae. Two lines of evidence support this conclusion. First in the Belemnoteutidae the rostrum is reduced and apparently conchiolinous while the proostracum is aragonitic. In *Diploconus* the rostrum is still calcareous though it has lost its radial fibres, while the proostracum is conchiolinous and greatly reduced. These morphological differences suggest that the Belemnoteuthidae and *Diploconus* may represent independent lines of descent arising from more generalized belemnoids with calcareous aragonitic shells. Secondly, if *Diploconus* is to be allied to the Belemnoteuthidae it must, by reason of the relatively thick rostrum, represent the most primitive member of the family. That such a relationship does not exist is suggested by the stratigraphic relationships, for *Diploconus* appears only after the Belemnoteuthidae had become highly specialized. Both the stratigraphic and the morphological evidence support Naef's view that the Diploconidae represent a stock quite distinct from the Belemnoteuthidae, though both families are characterized by a superficially similar tendency toward the reduction of the rostrum and the replacement of its original aragonitic structure.

The extant evidence suggests that *Metabelemnites* is best regarded as a primitive member of the Diploconidae. The evidence is incomplete largely because no data is avaliable on the condition of the proostracum of *Metabelemnites,* but it does show that the conotheca extends orad of the phragmocone for some little distance, a feature not found in *Diploconus* but well known in various of the Belemnitidae. As such, it may supply the link between the Diploconidae and other belemnoids. Unfortunately it is as yet uncertain whether the Upper Triassic *Metabelemnites* will establish a link connecting *Diploconus* with well defined Aulacoceratidae, as suggested by the dominance of these forms in th Triassic, or whether it links it instead to the Belemnitidae.

In approaching the problem of *M. philippii* the writer fully expected to find here evidence of the structural pattern which Dunbar (1924) figured for *Atractites,* namely a simple and well defined orthoceran living chamber orad of the phragmocone. Dunbar figured a series of "genera" supplying the transition from a straight nautiloid shell to a typical belemite. The first stage is a simple orthochoanitic orthoceracone such as was formerly called *Orthoceras.* In the next stage, which he called *Atractites,* the mantle had enclosed the shell and had secreted a small and relatively short rostrum on the original shell wall. The phragmocone was still well developed and modified by little more than the ventral position of the siphuncle, and a normal nautiloid living chamber was retained. The third step, indicated as *Belemnites* is marked by increase in the size of the rostrum, a shortening and widening of the original conch, now apparently the conotheca, a crowding of the septa, and the loss of the conotheca orad of the phragmocone except for the dorsal proostracum.

Unfortunately for this hypothesis nowhere among the species assigned to *Atractites* does there appear to be any form which shows conclusively such a living chamber as Dunbar indicated. *M. philippi* is practically alone among

the species assigned to *Atractites* in former years in agreeing with Dunbar's figure in the small size of the rostrum. Yet there does not seem to be evidence to warrant the interpretation of this species either as a primitive belemnoid, or one possessing a living chamber. As noted above, this Upper Triassic species seems to supply the link between belemnoids with larger and better calcified rostra and *Diploconus;* it is in short the first recognizable member of the Diploconidae which is one of several genetic lines in the Coleoida exemplifying reduction both in calcification and in mass of the internal shell. Further, this upper Triassic form connects the Jurassic *Diploconus* with the strongly calcified shells of the Aulacoceratidae insofar as stratigraphic relationships are concerned. The Aulacoceratidae, although recognized as high as the Lias, have been known from the Middle and Lower Triassic and even from the Permian. Yet these earlier species fail to show indication of a thin or small rostrum; instead it is quite massive. Indeed, the occurrence of large rostra among these earlier Aulacoceratidae is sufficient to suggest that once the mantle succeeded in covering the original shell wall, the secretion of calcareous material upon the conch may have been a coenogenetic feature, producing massive rostra at once instead of a series of rostra which increase gradually in size with the development of the Coleoidea.

The absence of conothecal striae in *Metabelemnites* is not decisive, since all known specimens are derived from rather coarse grained limestones unfavorable for the preservation of such structures. Morphologically the extension of the conotheca orad of the septum is far from unique, and is not sufficient to warrant any such interpretation. From what can be determined concerning the relationship of *Metabelemnites,* it supplies a link betwten the Aulacoceratidae or some other belemnoids which in any case had well specialized proostraca, and the genus *Diploconus* in which the proostracum is reduced, but in which there is no sign of a true living chamber. As such, there is no basis for applying any such interpretation to the genus as indicated by Dunbar's figure.

Species Formerly Assigned to Atractites

While the present study results in the proposal of two new generic names to accommodate some of the species formerly embraced by *Atractites,* it has by no means solved the problem of all of them. A considerable number of the described species are known only from portions of rostra. It seems that the Triassic age of many of these specimens and the smooth exterior of the rostra are the only criteria which have been considered in such cases, and insofar as the actual morphological evidence is concerned, they might as easily be placed in any one of several genera of the Belemnitidae. That the Belemnitidae proper have not been recognized prior to the Lias may be very largely due to this broad and loose usage of *Atractites.*

Ausseites will probably contain most of the better known Triassic and Liassic species formerly included in *Atractites.* It is readily distinguished from other genera of the Aulacocatidae by the smooth surface of the rostrum, but its distinction from various genera of the Belemnitidae presents some serious difficulties. Typical species can be readily recognized if the phragmocones are

preserved, for the conotheca expands orad only very gradually and the septa are very widely spaced. However, neither character is very adequate. Some species are known which approach the condition of the Belemnitidae in both the more rapidly expanding conotheca and the more closely spaced septa. *A. convergens,* as illustrated by von Mojsisovics (1902), has the widely spaced septa of the Aulacoceratidae, but its phragmocone is compressed and rapidly expanding. *A. conicum* (Mojsisovics, 1902, pl. 15, 16) is even more atypical. The phragmocone expands rapidly, the septa are relatively closely spaced, and the siphuncle is made up of strongly nummuloidal segments. This species is probably not a good *Ausseites.* Examination of a suite of *"Atractites"* in the U. S. National Museum reveals further than among those forms which would be included under *Ausseites* as defined above, there is considerable variation both in the shape of the rostrum, and the number and position of the shallow grooves on the apex of the rostrum. Possibly these criteria may eventually serve for further subdivisions of the genus. Such a course is not attempted here inasmuch as the extant illustrations and descriptions as well as such actual material as has been available do not supply enough information to permit the wide application of any such system to the species already described. Further, similar apical furrows and markings occur in various of the genera which have been assigned to the Belemnitidae, and aside from the general proportions of the phagmocone, no clear distinction seems to exist between *Ausseites* and members of this family.

The problem of the relationship of *Ausseites* resolves itself not into the problem of distinguishing it from other members of the Aulacoceratide, but in determining whether there is any reliable distinction between the Aulacoceratidae and the Belemnitidae. If so, any such criteria will find their greatest use in distinguishing *Ausseites* from various of the Belemnitidae with essentially smooth rostral surfaces. A survey of the literature shows that the distinction of the two families never seems to have been questioned. Yet there are practically no discussions which state clearly the basis for the recognition of the Aulacoceratidae. In most cases it appears from internal evidence that the slender and pauciseptate phragmocone have been the criteria most widely employed. Yet both features vary enough in shells with smooth rostra so that they fail to supply a clear basis for division just where it is most needed. Von Bulow-Trummer (1920) recognizes the division of the belemnoids into the "tribe" Protobelemnitidae, which contains only the Aulacoceratidae, and the "tribe" Eubelemnitidae, which contains all other families. The Protobelemnitidae are distinguished by the presence of a very long dorsal proostracum and a shorter ventral proostracum, while in contrast the Eubelemnitidae possess only a long dorsal proostracum. This feature, if valid, should serve to distinguish the Aulacoceratidae readily, but several difficulties both practical and theoretical are encountered in its application. The proostraca themselves are virtually unknown in these older belemnoids, but their form has been inferred from the condition of the conothecal striae. Unfortunately the conothecal striae are structures of such slight relief that they are visible only under exceptionally good conditions of preservation. It is feared that only a very small proportion of the Aulacoceratidae have been found well enough preserved to show these markings. Indeed, as Naef (1922) points out, transverse lines

on the surface of the rostra, such as are commonly shown in *Dictyoconites,* have often been mistaken for the conothecal striae. While there is no basis for rejecting the occurrence of a short ventral proostracum in the Aulacoceratidae, it does not follow that this feature persists throughout the family. Indeed, it is definitely known that no such ventral proostracum is developed in *Xiphoteuthis* Huxley, yet von Bulo-Trummer, while accepting the proostracal features as the criteria of the Protobelemnitidae, includes *Xiphoteuthis* not only as a member of the family, but as a subgenus of *"Atractites."* Naef (1922) has subsequently removed *Xiphotetuhis* to the new family Xiphoteuthidae, but this procedure was not influenced by the condition of the proostracum, upon which Naef seems to place very little reliance.

Problems relevant to the relationship of the various genera of the Coleoidea cannot be discussed at length at the present time. It is not surprising that there should be much uncertainty as to the relationship of these organisms in view of the exceedingly fragmentary nature of typical specimens. However, these organisms have been closely studied, largely by European paleontologists, and several different classifications have been proposed. The older arrangement of Zittel (1885), and Hyatt (1900) have been replaced by several revisionary works. The classifications of Pavlow (1915), Abel (1910), and Stolley (1918) have been synthesized by von Bulow-Trummer (1920) into one of the very few classifications in which the higher categories are succinctly defined. A very different classification was proposed by Naef (1921, 1922) which has some very definite advantages of its own. Unfortunately most of the works suffer from obscurity in the definition of the major taxonomic divisions, and fail to show clearly the reasons which lead the authors to depart from previous classifications. Further, even the limited experience of the writer in relation to the belemnoids has served to indicate that there are morphological problems, such as the integration of the anterior end of the rostrum with the proostracum, and the shell layers of the conotheca itself, which have not yet been studied sufficiently to warrant their application to any taxonomic system. In spite of the clear expression of phylogeny portrayed by Naef (1922), many uncertainties exist as to the actual relationship of the Coleoidea, and in particular in relation to the earlier Mesozoic belemnoids which will require much further study.

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Observations of General Vegetational Changes on a River Island in the Mississippi River

Charles A. Shull

During August, 1919, the writer made a study of the vegetation of western Kentucky along the Mississippi River. An earlier report[1] of this work dealt particularly with the history of an island which was formed in chute number 5, a channel separating Wolf Island from the state of Missouri. This island began to form in 1913, as the result of the stranding of a barge on a rock bar in the chute as the memorable floods of that year receded.

At the request of the late Dr. Edward M. Kindle, of the Canadian Geological Survey, the region was visited again in 1933, with the purpose of surveying the changes which had taken place during the fourteen-year period following the first investigation. Some attention was given to the vegetation of the flood plains along the river, but most of the studies were made on the island in the chute, and its connection with the Missouri bank of the chute.

This island which had been formed in 1913 was occupied in 1922 by an almost pure stand of cottonwoods (*Populus deltoides* Marsh.) ranging from 30 to 40 feet in height. By 1933 the island had become a part of the Missouri mainland.

The old chute of the river is now occupied by a thick growth of willows (*Salix nigra* Marsh), among which mud deposits have developed to such a depth that the old channel is almost level with the flood plain along the bank of the Missouri shore. The filling of the channel and the deposition of mud all over the island has proceeded with every flood whose crest has been higher than the island. Information obtained from local inhabitants indicates that the north branch of chute number 5 remained navigable for barges up to and including the flood period of 1922.

The position of this island as it existed in 1919 is indicated on Fig. 1. The outline of the island, and the new vegetation in the chute to the north and west of it are shown in the airplane photograph, Fig. 2.

Flood stages were lacking in this region of the Mississippi River during the four years from 1923 to 1926 inclusive. The black willows must have succeeded in completely occupying the north channel during this time and they must have grown to such an extent that even the very severe and repeated floods of 1927 did not destroy them. They now form a very close stand and probably retard the movement of water during floods and cause rapid deposition of sediments.

1 Shull, C. A., Formation of a new island in the Mississippi River. Ecology **3**:202-206. 1922.

The character of the soil has changed markedly all over the area. Formerly a cottonwood island with sandy deposits, it is now completely covered with a soft mud. This mud soil seems especially favorable to willows, and the extensions of the island vegetation to the north and west since 1919 consist almost exclusively of black willows. The willows which occupy the new mud lands were, in 1933, 30 to 35 feet tall, and 2 to 3 inches in diameter.

No means were available for a direct measurement of the height of the island. In 1919 a 43-foot stage of the Mississippi was required to inundate it. By 1933 it was estimated by those living in the neighborhood that a 46-foot stage was needed to cover it. If this estimate is approximately correct, it means that the former surface of the island now lies three feet deep in mud. The deposition of such a layer over an area of 100 to 120 acres represents approximately 500,000 cubic yards of deposit. This amount of material has been laid down in not more than eight or nine periods of deposition. Table 1 gives the flood data for the Mississippi River at Cairo, Illinois, from 1920 to 1933 (generously supplied by Mr. J. L. Kendall of the Louisville Weather Bureau

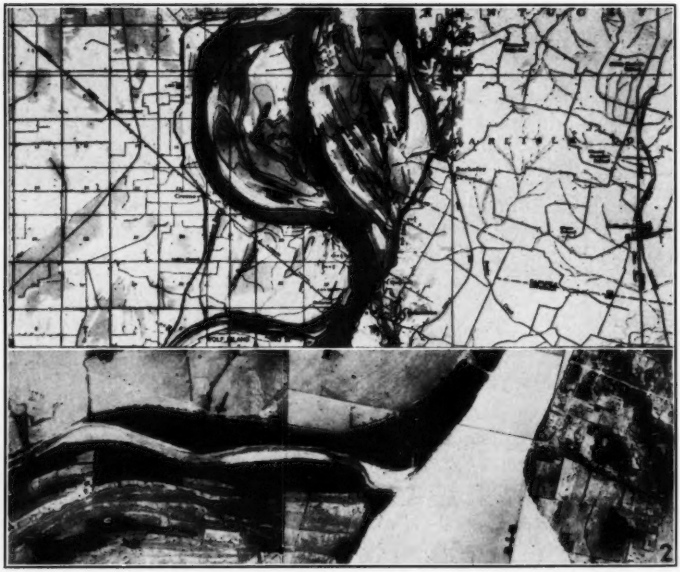

Fig. 1. Map of the region of the Mississippi River lying north of Wolf Island (no. 5); the island is indicated by an arrow on the meridian which crosses the middle of Kierce's island in chute no. 5.

Fig. 2. Airplane photograph taken over the island. The former area of the island is outlined by the taller trees. The photograph shows the eroding of the island by the chute current, by the unsymmetric shape of the toe-head. See figure 4 for the conditions along the south-east border of the island.

Station). This table, together with a similar table published in 1922, gives a complete list of the flood stages during the growth of the island from 1913 to 1933.

TABLE 1.—Flood Data, Mississippi River at Cairo, Illinois, 1920-1933

Dates	Crest time	Height in feet
1920, March 20 - May 8	March 31	51.4 feet
1921, none		
1922, March 16 - May 4	March 25	53.6 feet
1923, none		
1924, none		
1925, none		
1926, none		
1927, Jan. 2 - Jan. 12	January 7	48.9 feet
Feb. 2 - 13	February 6	48.9 feet
March 17 - May 5	April 20	56.4 feet
June 2 - 14	June 9	49.7 feet
1928, July 1 - 9	July 6	45.6 feet
1929, none		
1930, none		
1931, none		
1932, Feb. 2 - 22	February 16	51.8 feet
1933, March 27 - April 13	April 4	49.1 feet

The only one of these floods which may have failed to cover the island is the flood of 1928. The crest at Cairo is always somewhat higher than that at Columbus, Ky., and it is probable that at least a part of the island area was not inundated in 1928. The floods of 1927 were frequent and severe, and caused great damage along this section of the river, necessitating the removal of the remains of Columbus, Ky., to higher ground.

The vegetational changes on the main part of the former island may be discussed briefly. Although the undergrowth is often completely buried and apparently destroyed by the deposits of mud, annuals come in abundantly, while perennials surmount the mud between floods.

The flood of 1920 left no undergrowth on the area; and the same could probably be said of every great flood since that time, but particularly of the floods of 1927. If the trees once grow above the crests of the highest floods, they are relatively safe from destruction. The taller trees always survive. The original cottonwoods of 1913 are strong-boled trees which in 1933 were about 18 inches in diameter, and a hundred feet tall. Other trees noted as coming in among the cottonwoods were elm (*Ulmus*), box elder (*Acer Negundo*), sycamore (*Platanus occidentalis*), and mulberry (*Morus*). The principal lianas were *Rhus toxicodendron*, *Vitis* sp. (river grape), *Psedera quinquefolia*, and *Tecoma radicans*. These were not numerous as climbers, but Rhus covered some considerable areas as a ground cover. They will certainly become the main lianas, along with Tecoma, as the vegetation continues its development.

It seemed probable that the growth of the area had reached its maximum in 1933. The shape of the channel seemed likely to preclude much greater

increase in area; but it has no doubt grown higher with every flood which tops the former island. Erosion is impossible except along the edge of the area, mainly the southeastern edge, and deposition occurs on top of the area because the vegetation slows the current during the high waters. In the course of time the vegetation will become more or less indistinguishable from that of the flood plain forests of Missouri. The black willows in the north branch of the chute will probably persist for many years.

In the earlier report attention was called to the terrace-like levels of vegetation (Fig. 3) along the Mississippi River. The opinion was expressed at the time that such zones of vegetation had resulted from yearly seedings of willows and cottonwoods.

If the young seedlings are not drowned by floods during their early years, they become permanently established. High water is very destructive, and injury to willows even 10 to 12 feet tall may be severe if they are completely submerged. Figure 4 shows willows which have been injured by flooding, but which are still alive. In general the leaf development is very poor and many

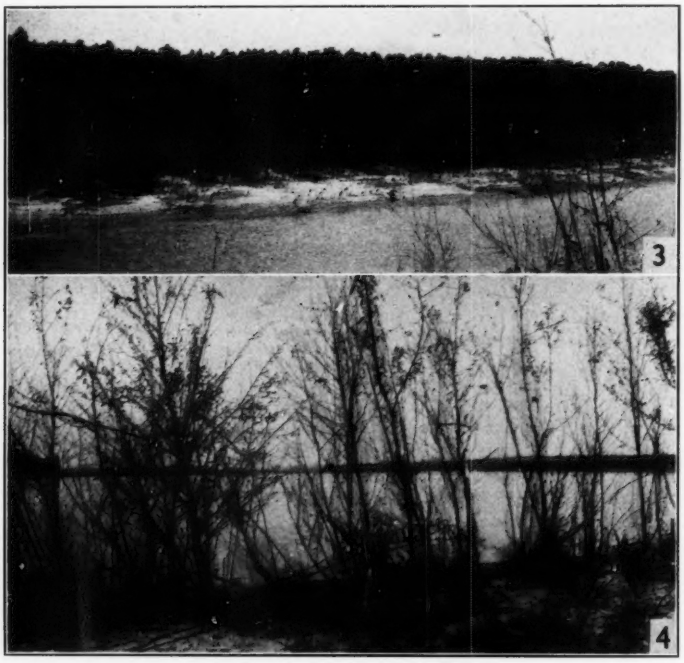

Fig. 3. Terrace-like zones of vegetation.
Fig. 4. Willows injured by flooding. Note poor leaf development.

stems are dead; but the roots have survived and show a tendency to coppicing, which would restore them ultimately provided other floods would not interfere. A more severe case of destruction is shown in Fig. 5. These willows lie opposite O'Brien's bend, on the east side of the river, where erosion is under way. While part of this injury is caused by erosion, it seems most probable that the major injury was inflicted by the higher water of floods, apparently an important factor in the destruction of young willows.

Adventitiuos roots developed during long floods have been observed on willows as high as 25 feet above the soil line. A striking example of slumping action from active erosion is shown in Fig. 6. In 1919, this part of the river bank was a great mud and sand flat covered largely by a scattered sedge vege-

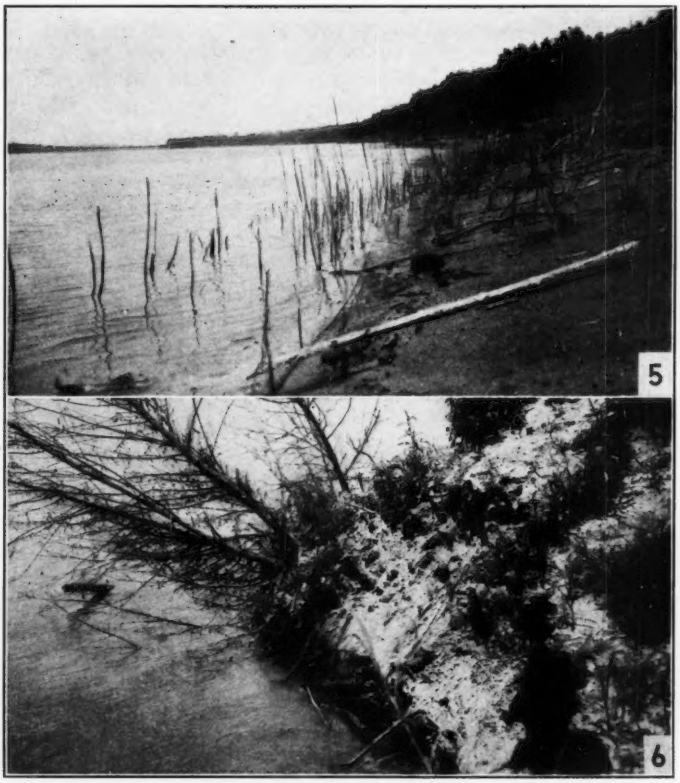

Fig. 5. Injury to willows caused by flooding and erosion.
Fig. 6. Slumping caused by active erosion.

tation. Later willows came in and now the river has begun to erode the mud deposits which were laid down about 15 years ago.

On the basis of observations made in many regions of zoned vegetation, it seems improbable that the ground is fully occupied at a single seeding. Several successive years of low waters may be required to form extensive zones. After they have been formed, natural selection seems to favor the taller individuals in the developing vegetation, whereas the shorter trees are more susceptible to flood damage. If any are destroyed, they are usually the smaller or weaker plants which are inundated for the longest continuous periods. They are under water sooner, and emerge later than the taller trees. Moreover, during periods in which no flooding occurs, there is competition for light. The short trees are so deeply shaded that they grow slowly and are damaged easily by floods. As a result of these forces of natural selection, the zones tend to become even-topped. Through preservation of the most rapidly growing and tallest individuals, and the suppression of the low-growing, possibly more recently established trees, this prominent feature of river scenery is developed. The seedlings which were found in 1933 could not establish such extensive zones as are found up and down the Mississippi, but, if seedings extend over several years without important flood damage, it would seem possible, through natural processes of selection, to produce the extensive zonation observed.

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Notes and Discussion

Lizards Killed by a Millipede

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It is a well-known fact that members of the arthropod class Diplopoda possess repugnatorial glands which make them unpalatable to animals which might otherwise prey upon them. These glands open laterally on the body; a set of them to each segment. Whoever has picked up one of these cylindrical, many-legged creatures. has experienced the obnoxious odor and the staining of the fingers which results from the release of a yellowish fluid from the stink glands. The odoriferous secretion is of foremost importance in the defense of these otherwise relatively vulnerable animals. The potency of the volatile discharge is vividly illustrated by the experience about to be related and by experiments which grew out of the initial observation.

A subadult western skink, *Eumeces skiltonianus* (7 cm. from snout to cloaca) had been confined for 2 weeks in a quart jar with a loosely fitting lid. It appeared to be in good physical condition when two millipedes of the species *Tylobolus stebbinsi* Chamberlin,* each about 35 mm. in length, were dropped into the jar with it. This was done because of lack of any other suitable container to restrain the diplopods —I wished to keep them alive for study. When I returned three hours later, the skink was dead. The jar smelled strongly with characteristic millipede odor. I assumed, tentatively, that the reptile had died as a result of inspiration of the fumes emanating from the bodies of the diplopods.

Recently, an experiment was performed to corroborate the preceding assumption. A subadult San Diegan alligator lizard, *Gerrhonotus multicarinatus webbii* (9 cm. from snout to cloaca) was captured and placed in a pint jar with a tightly fitting lid along with a large *T. stebbinsi* (60 mm. in length). The millipede had been placed in a double-walled, wire screen cage to prevent the reptile from coming into direct contact with it. The plan was to subject the lizard only to the volatile elements in the fluid secreted by the millipede. After a few minutes, during which the air in the jar was being charged with "millipede gas," the lizard began blinking. The eyes were opened for increasingly shorter intervals until at last they were held closed tightly. Thereafter they were exposed only when the reptile was startled by shaking the jar, and then they were blinked incessantly and were finally closed when the animal became calm. The vapor permeating the container was apparently exceedingly irritating to the conjunctival surfaces of the eyes.

After about 6 hours, the millipede was removed from the cage, since aside from the fact that the lizard's eyes were closed tightly, it seemed to be suffering no ill effect. The diplopod was not being stimulated sufficiently to cause it to release fluid from its stink glands; it was protected by the wire cage from jostling by the lizard. In the case of the skink, death occurred in three hours, but in this instance there was freedom of contact between the reptile and millipede.

After about 24 hours, following removal of the screen cage, the lizard began to show signs of grogginess. At 40 hours, its righting reaction was noticeably slowed. At 50 hours this act was barely performed. Shortly after that, the reptile was incapable of righting itself, and at 57 hours it was dead. The millipede was found to be dead at the end of the experiment. No marks of violence could be seen. The last time it had been observed alive was around the 40th hour. Perhaps it was killed by its own gas in the narrow confines of the jar.

* This species has been described recently by Dr. R. V. Chamberlin.

The lungs of the lizard were examined immediately following death but upon casual observation they appeared to be normal as compared with freshly killed non-experimental animals. There appeared to be no congestion of the pulmonary tissues.

In order to eliminate the possibility that the lizard might have died of suffocation, due to the limited amount of air in the jar, another and larger individual (11 cm. from snout to cloaca) was placed in a container of the same size with a tightly fitting lid. It was removed after a week (164 hours), in good condition.

The evidence at hand strongly suggests that the lizards died from inhalation of volatile elements in the repugnatorial fluid. It is very doubtful that either the skink or alligator lizard could have gotten fluid into the digestive tract even though both of these lizards characteristically protrude and retract the tongue at frequent intervals. It can be presumed that the millipede is distasteful to them because of the irritating property of its repugnatorial secretion as evidenced by the eye blinking response. Furthermore, I noticed no attempt at anytime on the part of the alligator lizard to seize the millipede, though it crawled about, often near the lizard's nose. I have force-fed millipedes of another species to an alligator lizard. The lizard showed no signs of discomfort and survived the experiment without ill effect. No regurgitation of the diplopods occurred.

Absorption of the poison through the skin is unlikely. The impervious reptilian integument would no doubt prevent its entrance. I have experienced no reaction to the fluid though I have often gotten considerable quantities of the substance on my hands and have, on occasion, made a definite effort to concentrate a quantity of the secretion on the tender skin between my fingers, allowing it to dry there.

Concerning the chemical nature of the repugnatorial fluid, Dr. Chamberlin (*in litt.*) informs me that with the majority of millipedes it is chiefly prussic acid, together with some iodine and chinone. Prussic acid is a hydrocyanide and is highly toxic. Perhaps, in gaseous form (as hydrogen cyanide), this substance is picked up by the hemoglobin in the blood stream, replacing the oxygen, leading to suffocation of the victim.

The survival value of such a defensive mechanism is so obvious as to need no discussion. It is a repelling, and when concentrated, can be a lethal substance. Its effect on other animals should be tested.

In conclusion, it appears to me of great interest that in spite of their general repugnance, some millipedes are eaten by other creatures. I repeatedly have found a small, slender, gray-brown species in the stomach of the red salamander, *Ensatina eschscholtzii eschscholtzii* Gray in the Santa Monica Mountains, Los Angeles County, California. When irritated, this species liberates great amounts of the repugnatorial fluid, in a quantity which, considering the small size of this diplopod, impresses me as being particularly copius. It is this form which I used in force-feeding the lizard mentioned previously. I find the fluid exuded by this millipede indistinguishable in odor and appearance from that released by *Tylobolus stebbinsi*.

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Book Reviews

GEOLOGY OF COAL. By Otto Stutzer. Translated and revised by Adolph C. Noé. Foreword by Edson S. Bastin. University of Chicago Press, Chicago, Ill. 1940. xiii + 461. 198 figs., incl. 5 folding plates; 87 tables. Cloth $5.

There has long been a great need for a comprehensive and scholarly treatise in English on the geology of coal, though a number of excellent works, mostly in German, have appeared. Several of these were written by the late Dr. Otto Stutzer, distinguished economic geologist of the Bergakademie at Freiberg, Germany. Despite certain shortcomings, the present translation of one of his most important books is a welcome addition to the rising tide of English literature on the enormously important and greatly ramified subject of coal.

This translation is based in part on the second edition (1923) of *Kohle (Allgemeine Kohlengeologie)* by Otto Stutzer and in part on a revision by him of certain chapters of that edition (III, "The Microscopic Examination of Coal"; IV, "The Origin of Coal"; V, "The Processing of Coal"; and the section in Chapter VIII dealing with gases in coal beds). Chapter X is omitted in the present book since it deals principally with statistical data concerning coal resources, production and reserves, and the necessary revisions had not been made at the time of Noé's death.

The translation is excellent despite the difficult style of the original. There are remarkably few errors, a fact which may well be credited to the competence in the subject matter and skill of editing of Dr. Gilbert H. Cady, of the Illinois State Geological Survey. It was he who appears to have undertaken the thankless chore of preparing the final form of this important but incomplete manuscript. In addition, Dr. Gilbert Thiessen of the Koppers Company, Pittsburgh, deserves considerable credit for his able assistance in the translation and revision of Chapter II, "Coal as a Rock; Survey of the Chemical and Physical Properties of Coal." The excellent triple index (General, Authors, and Places) of 32 pages length makes possible ready reference to almost any topic, a saving feature for a book of so heterogeneous a nature, and on the whole, so poorly organized.

Chapter I ("The Definition of Coal") is definitely too brief (two pages). A few theories or definitions are casually quoted but they are inadequately evaluated. An average example of Noé's failure to modify or revise statements properly made for the original audience but scarcely applicable to American readers appears on page 2, ".... A basis of distinction is needed...., since commonly coa' belongs to the state and coaly rock does not." Such general failure throughout the book to temper the subject matter for broader application is probably the most important and justifiable criticism of this work. Only in a few instances has a reasonable attempt been made to cite suitable and often times better non-European examples of the phenomena discussed. Without the reference to such classical examples as are known in American coal fields and in important coal areas of Asia, Africa and Oceania, for most of the subjects considered, the book can scarcely hope to command the attention of those for whom it was intended, ".... the geologist, mining engineer and other persons whose interests are concerned with the coal industry." It will at best remain an excellent treatise for reference work on the essence of the very important European interpretation and extensive literature.

On the whole the discussion of the origin of coal beds in Chapter VI is well done. Its scholarly approach and high academic plane is evident from the surprisingly wide selection of examples used for illustration. An occasional inappropriate term or mistranslation occurs as on page 174, line 9, where the substitution of "lamination" for "striation" would be desirable.

The evasive handling of the "Stratigraphy of Coal Deposits" (Chapter VII) and the omission of excellent American examples reduce greatly the value of the chapter.

In analyzing forty pages of the chapter, we find that it contains 27 tables and figures (all from European sources), and 151 references to various examples of certain phenomena, 15 of which are American and the rest European. Only 58 lines here deal with foreign examples and, interestingly enough, all but 3 of these 15 examples were taken from references published prior to 1907. The table of commercially important coal beds (p. 184) is incomplete and therefore misleading. A casual survey of the epic "Coal Resources of the World" published about the time of the first edition, or one of the briefer, but more recent, resumes such as that found in E. S. Moore's "Coal," quickly show the great deficiencies of the table. Greater use of the results of the two Heerlen Congresses on Carboniferous stratigraphy should have been made throughout this chapter and elsewhere in the book. The section on the naming of coal beds (pp. 229-230) is completely valueless in America and scarcely constructive for any locality.

Nothing can be gained by adding more instances of such general shortcomings. Chapters VIII and IX ("The Petrography of Coal Beds" and "Disturbances of Coal Beds"), though poorly organized, are voluminous and informative. Some positive statements are made which may be questioned, whereas certain excellent explanations have been overlooked. For instance, on page 277, in the discussion concerning large boulders in coal, Price's theory (Journal Geol. XL(1):62-73, 1932) has been omitted. Further the statement (loc. cit., line 16) that the nature of the vegetation of the Carboniferous precludes the possibility of a climate sufficiently cool to permit sizable ice floes is contestable. In this connection it may be noted too, that the important phenomenon of cyclical sedimentation in the Carboniferous is not treated at all. Further, the theory postulating great age differences of the Upper Paleozoic floras of the Northern Hemisphere and the famed Gondwana deposits seems to be tacitly accepted (p. 189). This thesis is now discredited by many of our foremost geologists who favor general time correlation of these deposits in the Pennsylvanian Period.

The statement (page 414, line 21) that "coal in the pebbles always corresponds to the type of coal in the nearest coal bed" may well be true, at least according to my observations, although conclusive proof has not yet been furnished. Here microfossil analysis alone provides the hope of actual proof. But the statement (loc. cit., line 25) that cannel coal predominates in coal pebbles certainly does not hold for the Appalachian coal field. Here they seem to be more often heterogeneous and banded splint or lower rank coals.

The omission of a revised and enlarged Chapter X is serious, for it deals with one of the most vital and interesting phases of the entire field and would be particularly valuable to those for whom the English edition is intended.

Throughout the work one is impressed by the different opinions presented on mooted questions. The value of these compilations is reduced by the general reticence to state conclusions preferred or in general to sum up the present status of the problem in question. There is need for including some one of the more reasonable recent classifications of coal and of an applicable terminology for the sake of clarity. Occasionally the reader encounters sudden, incongruous changes in subject matter from one paragraph to the next. In several instances confusing duplication is probably due to the change in approach to certain subjects in different chapters. This condition, which simulates that often found among various papers of a symposium, may be due to partial revision in one chapter and not in another. Large parts of the book bear evidence of incomplete revision by the author in 1923 of the original edition (1914). Had Dr. Cady been given more opportunity he would no doubt have been able to include much recent information and additional useful illustrations. Since the book was apparently intended for certain American readers, and because the United States alone produces nearly one-fourth of the world's supply of coal and has nearly two-thirds of the estimated reserves, as well as almost complete range of ranks, types and ages of coal and a wide variety of accompanying geological phenomena, it would seem reasonable to expect a less provincial revision which would contain more illustrations from other great coal areas.

However, even with these shortcomings, the book, as a reference, is good. In fact, the bibliography is excellent in scope and organization, and is quite complete up to

1920. There are some omissions of recent literature. On the whole it is the best bibliography of its kind and is far superior to the scattered references of the original editions both in organization and completeness. The translation, as such, is scholarly and the style and printing are excellent. Paleobotanists as well as geologists will be greatly assisted by it in gaining access to much of the mine of information locked in the depths of numerous foreign languages.—AUREAL T. CROSS.

THE FLOWERING PLANTS AND FERNS OF ARIZONA. By Thomas H. Kearney and Robert H. Peebles. United States Department of Agriculture Miscellaneous Publication 423. U. S. Govt., Washington, D. C. 1942. 1069 pp., 29 pls. $2.00.

The appearance of Kearney and Peebles's excellent work on the flora of Arizona is as welcome as one of the torrential rains which come now and then in the desert and break the long intervening periods of drought.

To understand the place this manual fills, it is necessary first to appreciate the situation which existed without it. For the average systematic botanist living under the sheltering wing of Gray's Manual or some similar work, the tasks of teaching groups of students to identify living plants and of having to determine miscellaneous specimens from a flora of perhaps 3,500 native species without a book to fall back upon must seem nearly impossible. However, identification of the vernal flora of the desert has been fairly satisfactory, since the species are similar to those of the arid regions to the west, and perhaps 60% or 70% of them are treated in the California manuals by Jepson and Munz. Determination of the aestival flora has been more difficult, since it has no counterpart in California, where there is no summer rain. The works on California botany do not include more than 20%, if that much, of the summer flora of the higher desert and the adjacent desert grassland and oak woodland, and it has been necessary to depend upon obsolete works, when they could be obtained. Chiefly these have been Wooton and Standley's "Flora of New Mexico" (1915), which is scarcely satisfactory for Arizona and not in harmony with the present International Rules of Botanical Nomenclature or with the most commonly accepted concept of genera and species, and Gray's "Synoptical Flora of North America" (1895-7), which has been the best general work on the flora of the State, despite the fact that it was only half completed. With this in mind, it is obvious that all interested in Arizona botany will welcome the appearance of Kearney and Peebles's "The Flowering Plants and Ferns of Arizona."

The manual of the Arizona flora is the culmination of sound research continued over a period of forty years, and it represents a critical evaluation of hundreds of papers dealing with various aspects of the flora of the deserts and mountains correlated with an intimate knowledge of the plants of the State as they occur in the field as well as the herbarium. To anyone who has had the privilege of visiting the well-kept herbarium at Sacaton, there can be no question that Dr. Kearney and Mr. Peebles have left no corner of Arizona untouched, and the numerous notes attached to the specimen sheets witness the thoroughness with which the plants have been studied. In addition to the work by the authors, various families and genera have been treated by twenty-two specialists, and these contributions add much to the value of the book, despite the inevitable variation in interpretation of taxonomic categories. An especially commendable practice of the authors is to furnish in a footnote for each family and genus a list of references to recent papers dealing with the group.

Few criticisms and no important ones are to be made. The greatest shortcoming of the book is lack of species descriptions, but a criticism based upon such a matter would be unfair, since the research and writing necessary to produce the first flora of a state as large and varied as Arizona is no small matter. The wonder is that it could be done at all, rather than that there was insufficient time to supply specific descriptions. Clear generic diagnoses and unusually thorough and workable keys compensate in considerable measure for lack of descriptions of the species. The very low rank assigned to varieties seems regrettable to the writer, but the question of prominence to be assigned to subspecific categories is a matter of individual opinion and policy. The lack of cita-

tion of the places of publication of the varieties and their synonyms seems inconsistent, since the full citations given for the entities recognized in specific rank include synonyms of varietal rank. Since no copy of the Gray Herbarium Card Index is available in Arizona, it would be of considerable help if these citations were given.

The interpretation of genera and species reflects distinctly a "middle of the road" policy or perhaps a tendency toward "conservatism," in the vernacular of systematic botany. Obviously, this, too, is a matter of individual policy, and it is not to be criticized by either "conservative" or "liberal." The units recognized or established are natural, and, although future writers may raise the varieties to species or demote the species to varieties, the entities are to be found in the living flora, and they are just as they have been described.

Despite the new era in study of the flora of Arizona ushered in by publication of Kearney and Peebles manual, the authors would be the last to suppose that the task of classifying the plants of the State is finished. The years of study of the flora of the desert and mountains without benefit of a manual has stimulated for a number of botanists an interest in the problems of classification and nomenclature underlying the tentatively accepted circumscriptions and names of many species and genera, and it is to be hoped that appearance of a single book summarizing the flora of Arizona will stimulate further investigation of these problems and focus attention upon them.—LYMAN BENSON, Department of Botany, Pomona College, Claremont, California.

THE MYCETOZOA OF NORTH AMERICA. By Robert Hagelstein. Mineola, New York, published by the author, 1944. 306 pp., 16 pls. (2-5 col.). $6.00, postpaid.

This book represents the fruition of many years of field collecting and of careful study of specimens at the New York Botanical Garden where the author is honorary curator of Myxomycetes. Readers will readily agree that "—roaming and collecting through the forests is a healthy hobby, with many thrills that come when an interesting form is found. The beauty of the fruiting bodies, with their variety of form and color, and the study of their curious life history, provide fascinating subjects for the microscopist." Great enthusiasm is requisite to accomplish the tedium of such a task as the preparation of this book. The result of these labors is a well prepared, technically accurate taxonomic reference work treating 285 species in 47 genera found in North America; of these 216 were collected one or more times in the field by the author. The keen stewardship of Mr. Hagelstein as a curator is evident by the herbarium of the New York Botanical Garden containing all but 12 of the 318 species of world distribution recognized by the author.

The classification followed is that of the Listers' "Monograph of the Mycetozoa"[2] to which it is a supplement for North America. Emphasizing the animal-like characteristics of the class stems from DeBary as pointed out by G. W. Martin[3] in his summary of the case for their fungus relationships. Tradition is followed in spite of the incongruity of their incorporation in the collections of the New York Botanical Garden and other botanical institutions. To one whose interests are chiefly in the biology rather than the taxonomy of the group, the "Introduction" describing the life stages is rather brief and indefinite. Bacteria are stated to serve as food for the slime molds but no mention of the fungi in this role is made. In the legend for plate 6 a practical method for obtaining assimilative plasmodia from dry, inactive sclerotia and growing them in culture dishes is described; the reader might appreciate this more in the Introduction. Protoplasmic streaming, perhaps the most interesting feature of the plasmodium to the amateur, is given but little discussion. A brief of the author's views on relationships (e.g. with the Acrasiales) might help to support the inference of their animal derivation. Only by the

1. GILBERT, H. C. 1935—Critical events in the life history of *Ceratiomyxa*. Amer. Jour. Bot. **22**:52-74.

2. LISTER, A. 1925—Monograph of the mycetozoa. London. 1894. Third edition revised by G. Lister. pp. 1-296. front., pls. 1-222.

3. MARTIN, G. W. 1932—Systematic position of the slime molds and its bearing on the classification of the fungi. Bot. Gaz. **93**:421-435.

experience of tracing hundreds of collected specimens through the keys and descriptions can their true value be appraised; not by the mere reading by a reviewer. The validity of the subclass, Exosporeae, might be questioned in view of the careful investigation of H. C. Gilbert[1] who concluded that Ceratiomyxa was "morphologically an endosporous Myxomycete." In the same paper on the basis of morphogenesis, *C. porioides* is acceded species rank. The recently described genus, Elaeomyxa (oil and slime), is discussed by its author. The striking abundance of authentic material studied is indicated by the statement on page 20 under *Badhamia magna* Peck—"(N.Y.B.G. nos. 6164, 7949, 10687, type material)" Mr. Hagelstein also had the privilege of viewing the type specimen of this species of Peck in the New York State Museum. The effect of environment on the characters of the plasmodial assimilative or feeding stage, and on the development of the fructifications, is apparent from the author's comments. An excellent compilation of cited or consulted taxonomic literature was prepared by Dr. John H. Barnhardt. Omissions will always plague the most careful bibliographer, as one such, in this instance; Povah, A. H. W. The Fungi of Isle Royale, Lake Superior. Papers Mich. Acad. Sci., Arts & Letters **20**:113-156. (1934) 1935. The list of Foreign Species not known from North America" may serve to alert collectors. The "Index to Genera and species" is informative, complete; and useful to the user of the book. The colored plates (Pls. 2-5) from drawings by Dr. W. C. Sturges are certainly worth special mention. The photographs (Pls. 1, 6-16) will be especially appreciated by those amateurs who have struggled with the difficulties of size, lighting, color, etc. in attempts to obtain likenesses in true perspective and detail.—FRANK L. HOWARD, Rhode Island State College, Kingston, R. I.

FISHES OF THE MIDDLE WEST. By Rachel L. Carson. U. S. Department of the Interior, Fish and Wildlife Service, Conservation Bulletin 34. U. S. Government Printing Office, Washington, D. C. 1943. 44 pp., 25 figs. 15 cents.

A part of this pamphlet acquaints the reader with the food qualities, adaptability to various methods of preparation, and seasons of availability of fishes of the Mississippi River and Great Lakes drainage basins. The bulk of the work is composed of biographies of common species. Particularly ample treatment is accorded the kinds of lesser market value such as the carp and buffalo fishes. An obvious and laudable aim is to encourage the use of these species and the bulletin doubtless contributes to the success of this movement which is currently shared by many in the area included.

Although well and popularly written, the publication contains little original information. The principal fault reflects the unfortunate policy of fisheries workers in the U. S. Fish and Wildlife Service to persist in the retention of technical names which are obsolete. These may be corrected to date as follows:

Obsolete Name	Present Correct Designation
Ictiobus cyprinella	*Megastomatobus cyprinella*
Ictalurus punctatus	*Ictalurus lacustris*
Leptops olivaris	*Pilodictis olivaris*
Lota maculosa	*Lota lota maculosa*
Esox reticulatus	*Esox niger*
Stizostedion glaucum	*Stizostedion vitreum glaucum*
Pomoxis sparoides	*Pomoxis nigro-maculatus*
Lepomis incisor	*Lepomis macrochirus*

Besides this violation of technical nomenclatorial practise, the species name of the common white sucker is misspelled and there is disregard of certain well established common names and substitution of extremely local ones. The value of comments on the extralimital electric catfish and those on evolution of this fish group in such a publication is questionable. Because of popularization, general information is very poorly documented and thereby loses much of its potential value to the more than casual reader. Inclusion of the opinion that even a restricted commercial fishery for crappies and bluegills would increase yield of these fishes to anglers, although progressive, may be out of place here. Omission of publisher's names detracts from the utility of some of the references in the bibliography.—KARL F. LAGLER, University of Michigan.

Walker Prizes in Natural History, 1945, for Essays on Mammals

Two prizes, founded by the late Dr. William Johnson Walker, are offered annually by the BOSTON SOCIETY OF NATURAL HISTORY for the two most acceptable papers written in the English language, on a subject chosen by the Board of Trustees of the Society.

PRIZES: A prize of sixty dollars may be awarded to the author of the best essay. This award may be increased to one hundred dollars, at the discretion of the judges of the contest, in the case of a paper of exceptional merit. A second prize of fifty dollars will be given only if the next best paper seems worthy of the distinction. No prize will be awarded unless the papers submitted are deemed worthy by the judges.

ELIGIBILITY: The competition for these prizes is not in any way restricted.

SUBJECT MATTER: Each paper must be the result of original and unpublished research personally conducted by the author and accompanied by an accurate bibliography and a review of general literature on the subject. All papers must be typewritten and in complete form for publication. Other things being equal, preference may be given papers showing evidence of preparation especially for this competition.

AUTHORSHIP: Each paper must be anonymous. It must bear a pseudonym placed in a conspicuous place on the first page. A sealed envelope, also inscribed with this pseudonym, must accompany the manuscript. The contents of this envelope will divulge the identity and address of the author. Anything in the essay which shall furnish proof of the identity of the author shall be considered as debarring the paper from competition.

CLOSING DATE: All competitors must submit their work to the Acting Secretary, Boston Society of Natural History, 234 Berkeley Street, Boston, Massachusetts, before May 1, 1945.

The Society and the judges assume no responsibility for publication of the winning papers. However, it is understood that authors should not publish their papers until after the announcement of the prize awards at the Annual Meeting of the Society in October, 1945.

—Margaret Baker, *Acting Secretary*

BOSTON SOCIETY OF NATURAL HISTORY,
234 Berkeley Street, Boston, Massachusetts,
October, 1944.

Subject for 1946: *Any subject in the field of insects—*

Correction

The May-August 1944 issue of the Taxonomic Index correctly noted that the writer erred in the publication of *T. intermedia* ssp. *absona* (Am. Midl. Nat. **31**:497. 1944). This inadvertent slip necessitates the following correction—

Tofieldia glutinosa (Michx.) Pers. ssp. **absona** (Hitchcock) comb. nov.
(*T. intermedia* ssp. *absona* Hitchc. Am. Midl. Nat. **31**:497. 1944 through error).

C. L. HITCHCOCK,
UNIVERSITY OF WASHINGTON,
SEATTLE, WASH.

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